Utah
Aquatic Invasive Species Management Plan

Prepared in coordination with

Utah Aquatic Invasive Species Task Force

by

Utah Division of Wildlife Resources

Publication No. 08-34

January 2009

Utah Aquatic Invasive Species Management Plan

Prepared by

Utah Aquatic Invasive Species Task Force

Larry B. Dalton, Chair, Aquatic Invasive Species Coordinator
Utah Division of Wildlife Resources

Approved by

James F. Karpowitz, Director, Utah Division of Wildlife Resources

_____ _____
Signature Date

Paul Niemeyer, Chair, Utah Wildlife Board

_____ _____
Signature Date

Gary Frazer, Co-Chair, Aquatic Nuisance Species Task Force
(Assistant Director for Fisheries & Habitat Conservation, U.S. Fish and Wildlife Service)

_____ _____
Signature Date

Timothy Keeney, Co-Chair, Aquatic Nuisance Species Task Force
(Deputy Assistant Secretary for Oceans, U.S. Department of Commerce/NOAA)

_____ _____
Signature Date

Jon M. Huntsman, JR., Governor, State of Utah

_____ _____
Signature Date

Utah Division of Wildlife Resources
Publication No. 08-34

Acknowledgements

The Utah Aquatic Invasive Species Management Plan was developed by the Utah Aquatic Invasive Species Task Force. The task force is comprised of tribal, federal, state, and local government natural resource managers; water user interests; and organized fishing groups who have either interest or authority for natural resource management actions. The task force and many individual members of the public provided direction and comment relative to the plan.

A glossary of terms used in this plan can be perused in Appendix J.

A special thanks is justly afforded to the following individuals (grouped with no logical order by agency), who are all members of the Utah Aquatic Invasive Species Task Force. Each member was generous in supporting development of the plan. All on the Task Force gave selflessly to achieve an improved situation for aquatic invasive species management in Utah.

Utah Division of Wildlife Resources:	Larry Dalton (chair) Walt Donaldson Evan Freeman Jenny Polloczek	Natalie Muth Dan Keller Crystal Stock
Utah Anglers Association:	Brock Richardson	
Utah Division of Water Resources:	Mike Suflita	
Utah State Parks & Recreation:	Bruce Hamilton	Dave Harris
Utah Department of Agriculture and Food:		Kent Hauck
U.S. Fish & Wildlife Service:	Bettina Proctor Chris Cline	Marianne Crawford
National Park Service:	Mark Anderson	Melissa Trammell
U.S. Forest Service:	Cynthia Tait	
Bureau of Land Management:	Justin Jimenez	
Central Utah Water Conservancy District:		Terry Hickman
Washington County Water Conservancy District:		Cory Cram Michelle Gregory
Bureau of Reclamation:	Russ Findlay	Amy Cutler
Utah Reclamation Mitigation Conservation Commission:		Maureen Wilson
Ute Tribe:	Jay Groves	

Table of Contents

List of Appendices

Executive Summary

Utah, unfortunately, has over the years become home to several species of Aquatic Invasive Species (AIS). Some AIS that exist in other areas of the nation and world have not yet made their way to Utah, but we fear they could. Prior to 2007, the Utah Division of Wildlife Resources only committed a small part of one staff person's time to the problem, although biologists statewide occasionally directed their efforts toward specific local AIS problems. Universities, tribal, federal, state and local government agencies, including private interests and organized sportsman groups also on occasion directed some effort toward the AIS problem. The advancing threat from *Dreissenid* mussels, of which the quagga mussel was found in Lake Mead during January 2007, spurred the state of Utah to action. It was the "straw that broke the camel's back." Threats and impacts from the multitude of AIS already in the state, not to mention those on their way, became fully recognized as needing more attention.

Utah Division of Wildlife Resources in concert with other partners within the Utah Department of Natural Resources launched an aggressive campaign in 2007 to:

1. Assess threats from *Dreissenid* mussels.
2. Advise the public, particularly decision makers, of the ecologic and economic impacts from *Dreissenid* mussels.
3. Develop needed policy to advise divisions within the Utah Department of Natural Resources and other departments within Utah state government about *Dreissenid* mussels and how Utah would react.
   NOTE: NR-07-D-11—"Policy to Prevent Invasion Of Zebra Mussel Into Utah Waters," assigned the Utah Division of Wildlife Resources as lead agency within Utah to carryout a program.
4. Initiate an emergency "Quagga Mussel Education and Implementation Plan."
5. Secure stable funding to conduct a more robust attack against AIS in general, with *Dreissenid* species being a primary focus.
   NOTE: The 2008 Utah Legislature appropriated $2.5 million general funds, of which $1.4 million is ongoing, to allow the Utah Division of Wildlife Resources to conduct an AIS program.
6. Develop new laws as needed.
   NOTE: The 2008 Utah Legislature unanimously passed the Utah Aquatic Invasive Species Interdiction Act and the Utah Wildlife Board unanimously passed Rule R657-60, Aquatic Invasive Species Interdiction. The rule allows enforcement of the Act, facilitating enhanced enforcement, which provides authority to make stops of trailered watercraft at boat launch sites, administrative check sites, and Utah ports of entry, including a mandate for self-certification pre-launch certifying mussel free boats. It also allows the closing of water bodies that become infested with *Dreissenid* mussels to ingress/egress of watercraft and other equipment until an acceptable plan for containment and control is developed.
7. Develop and implement a comprehensive Utah Aquatic Invasive Species Management Plan.

The Utah Aquatic Invasive Species Task Force, representing a multitude of tribal, federal, state, and local government agencies; water use interests; and organized fishing groups; was formed to prepare and guide implementation of this Utah Aquatic Invasive Species Management Plan. The plan was subjected to public review via Utah Division of Wildlife Resources' five statewide Regional Advisor Councils and approved by Utah's Wildlife Board and the State of Utah's Governor, which led to ultimate approval by the national Aquatic Nuisance Species Task Force.

The main thrust of Utah's Aquatic Invasive Species Management Plan is to deal with *Dreissenid* mussels, although many activities are ongoing with other AIS. New Zealand mud snails have been found in the Loa Hatchery, and they have been found on the Midway Hatchery property (not in the hatchery yet). Actions are ongoing in Utah's hatchery system to deal with the mud snail problem. Individual hatchery Hazard Analysis Critical Control Point plans are in place, and the Utah Division of Wildlife Resources New Zealand Mud Snail (*Potamopyrgus antipodarum*) Management Plan for Loa Hatchery has been implemented.

Utah Division of Wildlife Resources' AIS biologists and others have found New Zealand mud snails in river and stream segments previously not known as infested. Verification of New Zealand mudsnail identifications has been completed by Utah's Natural Heritage Program.

Others in the aquatic section aided by Utah Aquatic Invasive Species Task Force partners are moving forward to spray treat Eurasian Milfoil in Mantua Reservoir and Fish Lake. Re-treatments will re-occur as needed.

Additionally, spray treatment followed by burning of common reed (*Phragmites* spp.) has been ongoing for several years and will continue through the efforts of the Utah Division of Wildlife Resources' waterfowl personnel throughout Utah's wetlands along the east side of the Great Salt Lake and other places. Likewise, tamarisk treatment statewide has been ongoing for years. Utah Aquatic Invasive Species Task Force partners have been participants to varying degrees across the years, too.

A full time AIS coordinator is now assigned to the Utah Division of Wildlife Resources' aquatic section. An AIS outreach specialist is assigned full time to assist with outreach needs. Also, five full time AIS biologists have been placed in the aquatic section —one in each of Utah Division of Wildlife Resources' five regions. And, 35 wildlife technicians have been assigned as seasonal employees in the aquatic section to perform as watercraft inspectors; they were placed at a multitude of priority waters statewide. Most technicians were provided with a trailer-mounted decontamination unit capable of spraying high pressure, scalding (140 degree Fahrenheit) water, which will kill all the AIS known either within or threatening Utah. Five conservation officers have been placed to assist as needed with AIS law enforcement needs, as well.

Some of the Utah Aquatic Invasive Species Task Force partners have been able to secure funding to assist in this effort and others are attempting to secure funds.

In an attempt to better perform early detection of *Dreissenid* mussels, Utah Division of Wildlife Resources' Fishery Experiment Station and the Aquatic Research Program have coordinated with Utah State University's Fish and Wildlife Department to assess research opportunity to compare various early detection methodologies. Early detection could allow attack on an invading population of *Dreissenid* mussels, possibly controlling or eradicating them. Knowledge gained from this research may lead to protocols for early detection of other AIS, too, allowing successful eradication or early control. Availability of funds will direct how and when this research might be implemented.

Additionally, Utah's AIS biologists in 2008 have taken plankton samples from 38 Utah water bodies, for assessment by qualified labs for the presence of *Dreissenids*. The assessment will first use microscopy deploying cross-polarized light. If a positive finding for *Dreissenid* occurs, a portion of the same sample will be molecularly analyzed through two different deoxyribonucleic acid polymerase chain reaction tests (PCR) as a confirmatory assessment.

The *Dreissenid* mussel campaign, beyond water craft interdictions by AIS biologists, technicians and others, including Utah Division of Wildlife Resources' conservation officers, Utah State Parks and Recreation's rangers, other Utah peace officers and Utah Department of Transportation's port of entry agents, is mostly an outreach effort. That effort operates in partnership with the U.S. Fish and Wildlife Service's national "Help Stop Aquatic Hitchhikers" program. This allows coordination amongst all of the states in the nation in order to fight aquatic invasive species. Outreach presentations in Utah and at national meetings about AIS, particularly the quagga and zebra mussel threat, have been made at many interested tribal, federal, state, and local governments or sportsman organizations.

Significant actions for outreach implementation as supported by available budget will continue as follows:

1. Utah Division of Wildlife Resources aided by our many partners, including the Utah Aquatic Invasive Species Task Force, is placing the 100th Meridian Initiative's "Zap the Zebra" brochure (250,000 units per year) statewide at locations where boaters and anglers will encounter it. During 2007 the effort included direct mail by Utah State Parks & Recreation of the brochure to 65,000 registered boaters in Utah.
   NOTE: Utah Division of Wildlife Resources is negotiating with the Utah Division of Motor Vehicles to incorporate an AIS message in their annual vehicle registration packets to boaters, negating a need to direct mail the "Zap the Zebra" brochure in future years. Additionally, the Utah Division of Motor Vehicles' web site links to the AIS segment of Utah Division of Wildlife Resources' web site.
2. Utah State Parks & Recreation is direct mailing a notice annually to all fresh water boat dock users (500 units) in the state park system, detailing the quagga and zebra mussel threat, including need for decontamination of boats and equipment.
3. Utah Division of Wildlife Resources is placing table-top displays (5,000 units per

year) across Utah at restaurants, boat dealer counters and other places where boaters and anglers would encounter the message, urging the public to "Help Stop Invasive Mussels," and to properly decontaminate their boats and equipment.

4. Numerous highway billboards are being placed statewide, urging boaters to "CLEAN," "DRAIN," and "DRY" their boats to aid in the fight against the spread of AIS. Billboard presentation equates to 168 months of advertising display.
5. Utah Division of Wildlife Resources is placing signs (1,500 units per year as full color foam core 11" x 17") and identical posters (4,000 units per year as full color 11" x 17") across Utah in areas frequented by boaters and anglers.
6. Utah Division of Wildlife Resources is placing entry signs (150 units per year as full color metal 33" x 54"), similar to the aforementioned poster, that demand self-certification as “mussel free” by boaters prior to launch at all significant water bodies across Utah.
7. The corner stone of the outreach effort, which is directly linked to the watercraft inspections, is a self-certification program for boaters to certify that their watercraft have either not been contaminated with *Dreissenid* mussels, or that their boats have been properly decontaminated. Every boater contacted will be asked to certify pre-launch that they have done their part to "Help Stop Aquatic Hitchhikers." Boaters will be presented with a self-certification form and asked to sign and display it on the dashboard of their vehicle. Boaters who arrive at times when no agency personnel are present, will be instructed via the aforementioned metal entry signs to secure a self-certification form and to fill it out, displaying it on their dashboard. Containers making the self-certification form available 24/7 will be mounted with the aforementioned metal entry signs.
   NOTE: Launch will not be allowed for boats needing decontamination. And, decontamination units are located at or nearby boating waters in Utah.
8. The National Park Service at Lake Powell has been an outstanding cooperator, aiding the Utah Division of Wildlife Resources and leading by example. They have conducted a similar outreach program as described above and began it several years ago.
   NOTE: The National Park Service’s *Dreissenid* mussel campaign at Lake Powell has been interdicting boats from contaminated areas and conducting decontamination for several years.
9. A rapid response strategy is included in the Utah Aquatic Invasive Species Management Plan. It will guide the Utah Aquatic Invasive Species Task Force in dealing with new arrivals of AIS or the spread of existing AIS.

Introduction

Aquatic Invasive Species That Threaten Utah

Aquatic invasive species (AIS) are not strangers to Utah. In fact, numerous AIS species now inhabit Utah or threaten the state with immediate arrival. The list includes pathogens, fungi, algae, plants, mollusks, crustaceans, fish, amphibians and reptiles (Appendix A). Some have been present almost since the initial arrival of the pioneers to Utah in the mid 1800s, and the numbers of different species, their abundance, and their distribution seems to be on a constant march upward. AIS are defined as water-associated non-native plant and animal species that threaten the diversity or abundance of native species due to their uncontrollable population growth, causing ecological instability of infested waters, or economic damage to commercial, agricultural, aquacultural, or recreational activities dependent on such waters. The term AIS in many documents and laws is referenced as Aquatic Nuisance Species; for purposes of this plan both aquatic invasive species and aquatic nuisance species mean the same thing.

AIS are defined in part as non-native. However, not all non-native species are viewed as a nuisance, since many are not invasive. Some non-native species support human livelihoods or a preferred quality of life, although they can in some situations have adverse impacts on desired species (e.g. sport fish impacts on sensitive species).

Populations of AIS all over North America have expanded, spreading rapidly due to lack of natural controls, and their ability to adapt to a variety of habitats. AIS are known to cause significant ecological and socio-economic problems throughout the world. Just within North America, populations of AIS, such as *Dreissenid* mussel species (quagga mussel *Dreissena bugensis,* zebra mussel *Dreissena polymorpha*, dark falsemussel *Mytilopsis leucophaeta)*, New Zealand mudsnail *Potamopyrgus antipodarum*, Eurasian watermilfoil *Myriophyllum spicatum*, and parasites or diseases that attack aquatic animals, are increasing in prevalence. These and other AIS species either exist or are threatening to arrive in North America, and many will eventually threaten Utah, too.

Why Manage Aquatic Invasive Species in Utah

AIS are simply bad for Utah's environment and economy for a multitude of reasons. AIS challenge our native species, resulting in additional predation, out-competing them for food, displacing them from natural habitats or infecting them with disease. AIS obstruct flow in waterways, impacting municipal, industrial, and irrigation water supply delivery. AIS degrade ecosystems, reducing or threatening recreational or commercial fishing opportunities. And, AIS can cause wildlife and public health problems. These reasons are not all-inclusive, but alone they give cause for serious concern and need for aggressive management.

For Utah, the concern about AIS increased dramatically in the early 1990s with the arrival of Whirling Disease. Then, the alarm rang loudly when quagga mussels were discovered in Lake Mead, Nevada during January 2007. Soon thereafter the Utah Department of Natural Resources began an assessment of threats to Utah by *Dreissenid* mussels, and put policy NR-07-D-11 (Appendix B) into effect to prevent invasion of

Dreissenid mussels into Utah's waters. The policy assigned the Utah Division of Wildlife Resources as lead agency within Utah to carryout such a program. Concurrently, Utah Division of Wildlife Resources implemented a Quagga Mussel Education and Implementation Plan (Appendix C) for purposes of informing the public about threats and impacts from a *Dreissenid* mussel infestation. A specific target for outreach was decision makers who had authority to make funds available for plan implementation. The plan would also facilitate interdiction of watercraft transporting AIS, leading to decontamination of infested boats and equipment.

These latest efforts were not Utah's first steps at AIS management, but they certainly represented a rapidly changing attitude that AIS, particularly the *Dreissenid* mussel threat, would require a focused, well funded effort to achieve satisfactory management results. Prior to 2007, the Utah Division of Wildlife Resources only committed a small portion of one staff person's time to the AIS problem, although biologists statewide occasionally directed their efforts toward specific local issues. Utah Division of Wildlife Resources' Fish Experiment Station in Logan, Utah for decades has provided strong, national leadership in the fight against aquatic pathogens and innovations in fish culture. Universities, tribal, federal, state and local government agencies, including private interests and organized sportsman groups in Utah also have on occasion directed some effort toward different AIS problems. And, the Utah Department of Agriculture and Food's Fish Health Board is the lead agency endeavoring to regulate aquatic animal and pathogen movement into and within Utah.

Eurasian watermilfoil during the early to mid 1990s became established in northern Utah's Mantua Reservoir and southern Utah's Fish Lake; it's spreading primarily due to recreational boats. New Zealand mudsnail populations also seemed to proliferate all over the state during the mid 2000s, possibly moving through irrigation systems and on the soles of angler's felt-soled waders. However, the growing threat from a discovered, but well established quagga mussel population during early 2007 in the lower Colorado River drainage spurred the State of Utah to an accelerated level of action. It was the "straw that broke the camel's back."

Also in late 2007 a population of New Zealand mudsnail was found in southern Utah's Loa State Fish Hatchery, causing it to be quarantined. A New Zealand mudsnail management plan for the hatchery was written, implemented, and decontamination is underway (Appendix D). New Zealand mudsnail have since been discovered in early 2008 on the grounds of central Utah's Midway State Hatchery; fortunately mudsnails are not yet inside the hatchery facilities. (**Note:** Individual hatchery Hazard Analysis Critical Control Point plans are in place for every state hatchery.) Thus, threats and impacts from the multitude of AIS already in the state, not to mention those on their way, are fully recognized as needing more attention.

Again, the AIS problem increased in late 2007 when a population of zebra mussel was found in Pueblo Reservoir in south-central Colorado. Also in 2007 zebra mussels were discovered in San Justo Reservoir in central California. 2008 resulted in discovery of quagga and zebra mussels in the headwaters (Lake Granby, Grand Lake, Shadow

Mountain Reservoir and Willow Creek Reservoir) of the Colorado River in Rocky Mountain National Park, Colorado. And, the determination in late 2008 that zebra mussel have already infested Utah's Electric Lake in Emery County was a devastating discovery.

What's at Stake in Utah--Economic and Ecologic Impacts

Degradation by AIS of Utah's aquatic wildlife resources (species, habitats and water-based recreation areas) may well imperil not only those resources, but the economy of local communities in the state. Certainly, the compromising of sensitive species in Utah by AIS could lead to additional listings under the Endangered Species Act, which represents a failing for individual species' population health and welfare. Such action has the potential to hamper economic development in local communities, since compliance with conservation actions driven by the Endangered Species Act can be mandated. Sometimes compliance is costly, nonetheless important and needed, but it is not uncommon for development plans to be delayed or altered in order to meet Endangered Species Act compliance.

Additionally, anglers who fished in Utah since 1995, including anglers across the nation over the last two decades, have shown a propensity to redirect their recreational endeavors to something other than fishing when inconvenienced by difficult regulations, poor success, poor quality fish, or an unpleasant fishing experience (Dalton 2003 and 2005; U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 1991, 1996, 2001 and 2006). *Dreissenid* mussels and other AIS will lead to all of those situations. Once anglers quit the sport, it is very difficult to get them to return, which is evidenced by a slight decrease in fishing license sales in Utah. Aquatic conservation by the Utah Division of Wildlife Resources is mostly funded by angler's purchase of fishing licenses and angler associated federal aid to the state. Expenditure by the 375,311 anglers who fished in Utah during 2006 for goods and services that supported their angling efforts exceeded $708 million, supporting more than 7,000 jobs in Utah's communities (Southwick Associates, Inc. 2007).

Boating in Utah during 2006 was less than in 1999. The Institute for Outdoor Recreation and Tourism at Utah State University in a 2007 report for Utah State Parks and Recreation, showed 76,000 registered boats in Utah during 2006. Those numbers are a surprising increase of 800 over the previous year. The increase is notable in view of a long-term decline, since the acreage of water available for boating remains relatively constant in Utah. AIS impacts to boaters may further reduce their participation at lakes and reservoirs that become infested, since the boater's favorite lakes are those with quality fishing. For example, *Dreissenid* mussels can plug the water circulation system in boats, causing engines to overheat and become seriously damaged. Eurasian watermilfoil restricts boat use, particularly in the near shore zones. And, more mandatory decontamination protocols are being imposed, so boaters don't inadvertently move AIS while transporting their watercraft between recreation areas. It is estimated that lost revenue in Utah's communities due to decreases in boating could be substantial. Utah boaters annually expend at least $276 million for goods and services supporting their sport, which supports more than 4,300 jobs statewide (Harris 2008).

The two decade long history of *Dreissenid* mussels fouling water conveyance systems just in North America is well documented (O'Neill 1996). Expenditures for maintenance have been significant, with the infested areas spending nearly $100 million per year. *Dreissenid*'s spread across Europe outside their native range has caused similar economic challenges (O'Neill, 1996). No doubt, impacts from *Dreissenid* mussels and other AIS represent real threats to Utah's economy and could alter all Utahan's quality of life. The Utah Division of Water Resources has estimated based upon maintenance expenditures east of the 100th Meridian, that cost to Utah on an annual basis due to infestation by just *Dreissenids* could exceed $15 million (Pers. Comm. Mike Suflita. 2007. Senior Engineer, Utah Division of Water Resources). That estimate did not include maintenance cost to Utah's 1,200 miles of major pipelines or the vast system of secondary pipelines and irrigation systems within the state, nor Utah's 4,500 miles of canal.

Laws That Govern AIS Management

The following is a list and short summary of the primary laws that govern the control of AIS on a national basis as it affects Utah. Included are Utah laws.

National AIS Laws

1973 Endangered Species Act: The U.S. Fish and Wildlife Service administer the Endangered Species Act as part of its authority to affect AIS impacts that could extend to a listed species or listed critical habitat. The act, which is Public Law 93-205, has experienced several amendments across the years, and at its onset repealed the Endangered Species Conservation Act of 1969. The 1969 Act had amended the Endangered Species Preservation Act of 1966.

1990 Nonindigenous Aquatic Nuisance Prevention and Control Act: Due to the multitude of environmental and socio-economic impacts posed by AIS, many governmental and non-governmental entities have recognized need for regulation. In 1990 the Nonindigenous Aquatic Nuisance Prevention and Control Act was passed by Congress and enacted to address AIS problems in the United States, particularly in the Great Lakes. This legislation provided federal cost-share support for implementation of state AIS plans. The 1990 act established the national Aquatic Nuisance Species Task Force, which is co-chaired by the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration.

1996 National Invasive Species Act: The reauthorization of the aforementioned Nonindigenous Aquatic Nuisance Prevention and Control Act occurred in 1996 as the National Invasive Species Act. It established a national goal of preventing new aquatic nuisance species introductions and limiting the dispersal of existing AIS in all of the states. The National Invasive Species Act also specified that state AIS plans identify feasible, cost-effective management practices and measures that can be implemented by states to prevent and control AIS infestations in a manner that is environmentally sound.

The 1996 National Invasive Species Act established six Regional Panels across the nation to serve as advisory committees to the national Aquatic Nuisance Species Task Force.

Utah's Governor appointed Utah Division of Wildlife Resources to represent Utah as a member on the Western Regional Panel, which is chaired by the U.S Fish and Wildlife Service.

Additionally, the 1996 act authorized the 100th Meridian Initiative as an effort to keep *Dreissenid* mussels east of the 100th Meridian. The initiative resulted in five River Basin Teams. Utah Division of Wildlife Resources is Utah's member on the 100th Meridian's Colorado River Basin Team.

The 1996 National Invasive Species Act directed the U.S. Coast Guard to establish regulations and guidelines to control the introductions of AIS via ballast water discharge into waters of the United States. It also directed the U.S. Army Corps of Engineers to develop a program for research and technology to control *Dreissenid* mussels and to make information available on control methods.

Executive Orders: The 1999 the Executive Order 13112 on Invasive Species established the national Invasive Species Council (Secretaries of State, Treasury, Defense, Interior, Agriculture, Commerce, Transportation, and the Administrator of the Environmental Protection Agency). Its purpose is to oversee activities of existing federal organizations that address invasive species issues in order to increase public awareness, coordinate federal and state activities, provide technical assistance and research, and prevent importation of nuisance species.

2008 Lacey Act: The U.S. Fish and Wildlife Service, amongst other agencies, administer the Lacey Act, which is Public Law 110-246, as part of their authority to prohibit trade in wildlife, fish, and plants that have been illegally taken, possessed, transported or sold. The act, originally passed in 1900, has been amended several times; the most significant ones occurred in 1969, 1981, 1988 and 2008. The act further regulates activities involving specified species deemed to be injurious to the United States.

Other Federal Activity That Relate to AIS Management: Many other federal acts and agencies in-part focus upon AIS management. The following actions and laws have significance to Utah.

> The Bureau of Reclamation administers a small, but significant acreage in Utah as "withdrawals" from other federal land management agencies for purposes of managing water development projects. They exercise AIS management on those properties. And, the Upper Colorado River Regional Office for the Bureau of Reclamation is currently preparing a management plan that focuses upon AIS management.
>
> The Clean Water Act, administered by the Environmental Protection Agency, strives to eliminate introduction of toxic substances into waters of the United States to ensure that surface waters are suitable for human sports and recreation. Additionally the Clean Water Act regulates discharge of dredge and fill materials into wetlands;

enforcement as it relates to wetlands is coordinated by the U.S. Army Corps of Engineers.

The Plant Protection Act, administered by the U.S. Department of Agriculture Animal and Plant Health Inspection Service, prohibits introduction and dissemination of plant pests and noxious weeds.

The National Forest Management Act, the Federal Land Policy Management Act, and the National Park Act, administered by the U.S. Forest Service, Bureau of Land Management, and National Park Service, respectively, regulate native species, non-indigenous species introductions and habitat health on most of the federal land in Utah.

The Central Utah Project Completion Act, administered by the Utah Reclamation, Mitigation Conservation Commission, besides providing for the completion of the Central Utah Project and maintenance of its facilities, affords enormous mitigation opportunity and perpetual funding for either unrecognized impacts or a continuation of mitigations for wildlife impacts.

The Farm Bill, administered by the Natural Resources Conservation Service, working in close partnership with Utah's Association of Conservation Districts, strives to improve private agricultural lands for wildlife habitat and agricultural purposes. In part, they target management of AIS as they affect production of crops or product from private land.
Note: the Natural Resources Conservation Service manages the National Invasive Species Information Center (www.invasivespeciesinfo.gov).

Several Native American tribes--Navajo, Northern Ute, White Mountain Ute, Northern Goshute, Southern Goshute, Paiute, Shoshone--exist or have hunting and fishing rights within Utah. The Ute Tribe and the Navajo Tribe each control significant areas (e.g. the Navajo Nation borders most of the southern border of Lake Powell and the Ute Nation includes several boating waters) with potential for infestation by AIS, particularly *Dreissenid* mussels. The other tribes have limited resources at risk where AIS could become an issue. The tribes under treaty with the United States maintain absolute authority for resource management on their lands, but are advised by the U.S. Fish and Wildlife Service concerning wildlife management issues.

Several international agreements also afford protection from AIS for the United States.

Utah Laws That Relate to AIS
Utah Code, section 23, establishes Utah Division of Wildlife Resources as the authority for wildlife management in the state, but the authority only extends to species defined as "protected wildlife." Thus, neither Utah Code nor associated rule provides authority for the management of plant species by Utah Division of Wildlife Resources, including those plant species recognized as AIS. Chapters 13 through 27 of section 23 in the Utah Code and an array of associated Utah Rules address wildlife management issues regarding

protection, management, take, possession, importation and exportation of protected wildlife, which includes quagga and zebra mussel considerations, making them prohibited species. Chapter 27 is the codification of the Aquatic Invasive Species Act (Appendix E1), and authority for enforcement of the Act is facilitated by Rule R657-60, Aquatic Invasive Species Interdiction (Appendix E2). The Act and Rule only consider *Dreissenid* species, providing greater authority for Utah to interdict watercraft and equipment or inspect waters infested with *Dreissenid* mussels. Utah Division of Wildlife Resources, Utah Peace Officers (includes Utah State Park and Recreation rangers), and Utah Port of Entry Agents now have authority to inspect equipment to determine contamination by *Dreissenid* mussels, particularly equipment that has been at any infested waters within the last 30 days. The authority extends to compelling decontamination as necessary. Additionally the authority allows closure of infested water bodies until the operator has developed a satisfactory plan to control and eradicate *Dreissenid* mussels.

Utah Code [4-2-2L (definitions 4-17 and 4-36-1)] provides the Utah Department of Agriculture and Food authority over noxious weeds, some of which are AIS. Management of AIS plant species in Utah results from interagency cooperation, exercising other agency's or private land owner's authority. Most AIS plant associated management activity in Utah involves cooperative arrangements between Utah Department of Agriculture and Food, Utah Division of Wildlife Resources, and Utah Division of State Lands and Forestry, State Institutional Trust Lands Administration, Utah State Parks and Recreation, along with the aforementioned federal land management and conservation agencies.

Utah Code [72-9-502 (definition 4-1-8)] and Rule R58-1-16(C) requires that all vehicles importing aquatic animals into Utah or through Utah must have documentation (Livestock & Fish Movement Report). Imported aquatic animals and their documentation are subject to inspection either at Utah ports of entry or at Utah Department of Agriculture and Food offices; entry denial, fines, or other action may occur. The Utah Department of Agriculture and Food works cooperatively on aquatic animal importation and transportation with the Utah Division of Wildlife Resources and the Utah Department of Health under a memorandum of understanding. Utah Department of Agriculture and Food provides standards for importation of aquatic wildlife for aquaculture, control of depredating aquatic animals, enforcement of rules, prevention of disease, and spread of disease among and from imported aquatic animals, and regulatory decisions for suspect disease endangerment in fish. They also through the Fish Health Program regulate entry permits for all national and international importations of aquatic animals for aquaculture purposes into Utah. Utah Division of Wildlife Resource and Utah Department of Agriculture and Food work cooperatively to grant health approvals for imported aquatic animals. This oversight extends to federal, state and private aquaculture facilities. And, because live fish (and water) are imported, the fish health approval process is completed for each aquaculture facility on an annual basis. The approval process includes review of current status of AIS at each facility, AIS proximity to each facility, and AIS proximity to export locations. The applicant is required to follow certain procedures to treat, test, or remove AIS from the fish and the water.

Importation of ornamental fish, including those deemed to be AIS, are not effectively regulated, but if the Utah Department of Agriculture and Food or the Utah Division of Wildlife Resources determines that an introduction of ornamental fish poses a disease risk for aquatic animals, then existing rules may be the vehicle to regulate the private ornamental fish industry to protect against AIS. The spring viremia of carp virus is now applied as needed to ornamental fish.

Additionally, certain "emergency prohibited" and "prohibited" pathogens fit the definition of AIS--viral hemorrhagic septicemia, whirling disease, Asian tapeworm (*Bothriocephalus acheilognathi*), and the trematode *Centrocestus formosanus*. Utah Department of Agriculture and Food requires treatment or testing of all proposed imports that could be host species or carriers or even susceptible hosts of these pathogens. (Note: The Asian tapeworm host list is attached as Appendix F.) In the unfortunate event of an aquaculture facility becoming infested by AIS, quarantine may be imposed where it is reasonably necessary to protect aquatic animals within the state. Release of any live or dead imported aquatic animal into public waters is illegal.

The Utah Code (17B-1-103 and 17B-2a-1003) establishes Water Conservancy Districts as political subdivisions of the State of Utah to develop water supplies for their service areas. They are primarily a wholesaler of water to other agencies (cities), and they own and operate a multitude of water storage, treatment and delivery facilities, some of which are major recreation reservoirs and State Parks. The Water Conservancy Districts have authority to protect and maintain their facilities in face of an AIS threat.

Other Efforts to Facilitate AIS Management

Utah Division of Wildlife Resources as a member of the Colorado River Fish and Wildlife Council, the Association of Fish and Wildlife Agencies and the Western Association of Fish and Wildlife Agencies is in constant contact with a multitude of international and national wildlife management agencies and other interested publics attempting to deal with AIS. These groups are regularly stimulated to become more aggressive by the national Aquatic Nuisance Species Task Force, who is proposing that the Western Governors Association meeting in 2008 include the topic of AIS in order to bring more focus on AIS issues from the top administrative office in the various states of the west. Previously in 1998 and 2005, the Western Governors Association passed resolutions 98-018 and 05-11 dealing with "Undesirable Aquatic and Terrestrial Species" and "Undesirable, Invasive Aquatic and Riparian Species," respectively. The Utah Department of Natural Resources already has strong support from the Utah Governor's office and the Utah legislature. The Utah Department of Natural Resources has urged Utah's governor to stimulate other western governors to more fully and aggressively deal with AIS.

Additionally, Utah Division of Wildlife Resources has taken a lead role in the west for initiating an AIS program with significant gubernatorial and legislative support for program budget. As a result, an array of western states have been in constant contact, seeking advice about "how did Utah do it." The Utah Division of Wildlife Resources has shared process and outreach product with an array of western and other states. Regarding

the states that surround Utah, Idaho already has an approved AIS plan; Colorado is in the process of preparing a plan; New Mexico is showing progress toward an AIS plan; Nevada and Arizona, also have approved AIS plans. Unfortunately, Wyoming seems to not be doing much, although Wyoming shares Flaming Gorge Reservoir with Utah—the reservoir is at great risk for infestation by *Dreissenid* mussels.

Action Plans and Hazard Analysis Critical Control Point Plans for Utah
Already, several action plans dealing with AIS exist within Utah (e.g. National Park Service's "Zebra Mussel Prevention at Glen Canyon National Recreation Area;" Utah Division of Wildlife Resources' "Action Plan for Containment of Quagga Mussel at Lake Powell," "Quagga Mussel Education and Implementation Plan," and "New Zealand Mudsnail (*Potamopyrgus antipodarum*) Management Plan For Loa Hatchery"). The same is true for Hazard Analysis Critical Control Point plans that in-part address AIS in Utah (e.g. U.S. Fish and Wildlife Service's "Utah Field Office Hazard Analysis Critical Control Point Plan," "Ouray National Hatchery Hazard Analysis Critical Control Point Plan," "Jones Hole National Hatchery Hazard Analysis Critical Control Point Plan;" and Utah Division of Wildlife Resources' 12 Utah State Fish Hatchery Hazard Analysis Critical Control Point plans—Fish Experiment Station, Loa, Midway, Kamas, Springville, Whiterocks, Mantua, Glenwood, Egan, Mammoth Creek, Wahweap, and Fountain Green). Others action plans and Hazard Analysis Critical Control Point plans will likely result, providing greater focus for AIS management at specific locales in Utah.

Purpose of Utah's AIS Management Plan
In 2008, Utah Division of Wildlife Resources formed and chaired a Utah Aquatic Invasive Species Task Force for the purpose of developing and implementing this Utah Aquatic Invasive Species Management Plan. Members of the task force represent multiple tribal, federal, state, local and private conservation entities, and they are listed in the Acknowledgements section of this plan. Plan implementation is ongoing, and each entity of the task force shoulders varying degrees of responsibility for program conduct, which is determined by their statutory authority and budget strength during individual years. An Implementation Table for the plan is presented as Appendix K.

The primary purpose for a Utah Aquatic Invasive Species (AIS) Management Plan is to develop and document a program and associated protocols to be implemented for AIS management within Utah. The Utah plan has been developed to be strategic in scope; it will serve as the foundational document to guide planning and to conduct work as it relates to AIS in Utah. And, at times it will serve as a supportive document for AIS grant applications. The plan will undoubtedly be the base from which other AIS action plans tier.

The Utah Division of Wildlife Resources has committed numerous full time equivalencies (25.21) to the Utah AIS program as follows:

Statewide AIS Coordinator;
Outreach Specialist;
5 Regional AIS Biologists;
35 Wildlife Technicians (seasonal watercraft inspectors);
5 Conservation Officers to assist as needed with AIS enforcement issues.

Additionally, Utah Division of Wildlife Resources has secured $2.5 million from Utah's Legislature for AIS program work in FY2008 and FY2009, of which $1.4 million is ongoing General Funds. Multiple outreach products--brochures, flyers, signs and billboards, 26 trailer mounted decontamination units, and routine operational costs for Utah Division of Wildlife Resources' staff are supported by the funds. Implementation of this plan is entirely dependant upon sufficient budget being made available.

The U.S. Fish and Wildlife Service's Denver Colorado Regional Office maintains an Aquatic Nuisance Species Coordinator. The U.S. Forest Service's Intermountain Regional Office in Ogden, Utah maintains an Aquatic Nuisance Species Coordinator, too. And, the Bureau of Reclamation's Regional Office in Salt Lake City, Utah also maintains an intra-agency AIS task force. All three of these agencies serve on the Utah AIS Task Force. Each position is funded by its respective agency such that significant programmatic support is directed toward implementation of Utah's AIS Management Plan.

All of the other Utah AIS Task Force members have additional agency roles besides their assignment to the Utah AIS Task Force. They are individually committed to keep AIS in strong focus within their respective agencies, including the provision of funds and personnel, when possible, for in-the-field operations.

Goal of Utah's AIS Management Plan

The goal of the Utah AIS Management Plan is to improve the ability of natural resource management entities within Utah to prevent invasion of AIS into the state, and to contain AIS through accepted management practices to areas that are either already infested or become infested.

Objectives and Strategies of Utah's AIS Management Plan

Outreach Objective**:** The Utah AIS Management Plan will establish and increase outreach efforts directed at public education. The intent is so Utah's public, particularly the media, governmental agencies, outdoor-associated recreational organizations, boaters, and anglers will realize the threats and impacts from AIS, and become partners in AIS education, interdiction and decontamination, as well as management.

- **Media Strategy:** Coordinate Utah's media (national, regional, statewide and local newspapers, magazines, radio stations and television stations, including targeted programming ("Utah at Your Leisure" and "Roughin It Outdoors") to repeatedly tell the AIS story, by identifying opportunity for the media to market their publications and broadcasts, promoting the "Stop Aquatic Hitchhikers" slogan in combination with the decontamination protocols.

- **Public Education Strategy:** Educate the public, particularly Utah boaters, at a variety of venues (e.g. organized angler and boater meetings, International Sportsman Expo, Greenspan Boat Show, Garden Show, state

and county fairs, launch sites and Utah's Ports of Entry) about AIS. The process will be to explain the AIS issue, and encourage the public to spread the "word," creating peer pressure for decontamination compliance. This strategy also includes presentations to natural resource management agencies within Utah and across the west about the AIS issue.

- Pursue cooperative opportunities to expand the education strategy to venues like the Living Aquarium and their educational van (they visit schools in the Wasatch Front area of Utah), Hogle Zoo and their docent education program (they visit schools statewide), and the Utah Natural History Museum, all located in Salt Lake City, UT.

- Display AIS outreach product produced by Utah Division of Wildlife Resource statewide (e.g. highway billboards, tailgate wraps on UDWR trucks, boat launch ramps, water-based recreation areas, boat dealers and marine repair shops, restaurants, local dive shops, and sporting good stores).
  Note: Cabela's and Sportsman Warehouse outlets are each willing and have facilities that can be used for public AIS presentations.

- Pursue opportunity to make AIS presentations at venues where water user groups gather (e.g. Utah Water Users Conference, river basin meetings, water rights managers meeting, etc.).

- **Next Generation Education Strategy:** Coordinate with Utah's educators in concurrence with the state science coordinator to educate the next generation of boaters by developing formalized in-class-room tutorials for secondary level school teachers to present to their students. The educational content must correlate to Utah's core curriculum and be done in cooperation with Project WILD.

- This strategy also includes web site development for AIS message delivery, and the sharing of educational material amongst educators, the Utah AIS Task Force and other states.

- Coordinate with appropriate local university and college personnel to make AIS presentations to their students, either in classroom settings or as a visiting lecturer at organized symposiums.

Interdiction and Decontamination Objective: The Utah AIS Management Plan will facilitate increased interdictions of boats and equipment contaminated with AIS, requiring decontamination under authority of the Utah Aquatic Invasive Species Interdiction Act and Rule R657-60 Aquatic Invasive Species Interdiction in order to control the spread of AIS.

- **Interdiction Strategy:** Utah Division of Wildlife Resources' staff, including authorized volunteers, Utah Peace Officers, which includes Conservation Officers and state Park Rangers, and Utah Department of Transportation Port of Entry Agents, under authority of the Utah Aquatic Invasive Species Interdiction Act, and other properly trained natural resource management personnel, will interdict boats at launch ramps, administrative check sites, and Utah's Ports of Entry to detect boats and equipment contaminated with AIS.

- **Decontamination Strategy:** Boat owners and operators will be contacted in-the-field or at a variety of other venues, including through media publications or broadcasts, one-on-one education or at group presentations, in order to tutor them about AIS. The boaters will be provided guidance about how to decontaminate their watercraft and equipment as per established protocols.

    - **Do-it-Yourself Decontamination:** Boat owners must clean and drain their boat and equipment as they leave a water body, then dry it for an appropriate amount of time between boating trips at home.

        - Clean mud, plants, animals or other debris from boat or equipment;
        - Drain the ballast tanks, bilge, live wells, and motor;
        - Dry boat and equipment for 7 days summer, 18 days spring or fall, or freeze the boat and equipment in winter for 3 days;

or

    - **Professional Decontamination:** Utah Division of Wildlife Resources' AIS Team (Appendix H), including authorized volunteers, Utah Peace Officers, which includes Conservation Officers and state Park Rangers, and Utah Department of Transportation Port of Entry Agents, under authority of the Utah Aquatic Invasive Species Interdiction Act, and other properly trained persons, will decontaminate boats and equipment infested with AIS as per established protocols (Appendix I). This effort due to capitalistic opportunity is intended to induce proper decontaminations by private vendors.

        - Wash the trailer and boat inside and out, including flush ballast tanks, bilge, live wells and motor with high pressure, 140 degree scalding water.

Management Objective: The Utah AIS Management Plan will facilitate opportunity to apply contemporary natural resource management practices in order to regulate,

control and eradicate AIS, allowing rehabilitation of infested areas followed by documented monitoring of success in all phases of management.

- **Plan Development Strategy:** Utah Division of Wildlife Resources will prepare, implement and maintain a Utah Aquatic Invasive Species Management Plan, including periodic updates as scientific information evolves regarding AIS management, in concurrence with the Utah Aquatic Invasive Species Task Force and the U.S. Fish and Wildlife Service's national Aquatic Nuisance Species Task Force.

- **Public Review Strategy:** Utah Division of Wildlife Resources subjected the draft Utah Aquatic Invasive Species Management Plan to a public review process that included Utah Division of Wildlife Resources' five Regional Advisory Councils located throughout Utah, approval by the Utah Wildlife Board (Appendix G). Once approved by the Utah Wildlife Board occurred, approval by the Utah Governor's Office was secured. Then, ultimate approval by the U.S. Fish and Wildlife Service's national Aquatic Nuisance Species Task Force ensued.

  The Utah Wildlife Board via the five regional advisory councils, as a matter of normal procedure, will re-review the plan every five years once it is approved.

- **Implementation Strategy:** Utah Division of Wildlife Resources will work with Utah's Department of Natural Resources, Utah's Legislature, Utah AIS Task Force and other natural resource management entities to secure adequate funding and cooperation for plan implementation and continuance.

- **Research and Technology Strategy:** Utah Division of Wildlife Resources has already contacted Utah State University's Fish and Wildlife Department to assess early detection methodologies, particularly biological arrays using protein markers for identification. Additionally multiple researchers at various labs have been quarried about the multiple, different deoxyribonucleic acid polymerase chain reaction tests (PCR) that are available. Further research may evolve based upon findings, need and available funds. It is intended that funds will be secured to maintain a long-term graduate research effort at Utah State University to be directed toward AIS issues.

  Additionally, Utah Division of Wildlife Resources Fishery Experiment Station, working in concert with Utah's other state fish hatcheries and other research institutions across the nation, perpetually assesses new and different methodologies to protect aquatic animals from AIS.

- **Control and Restoration Strategy:** The control of AIS is problematic to the extent that all the different species require varying approaches. For some species control or containment methods are poorly understood, although interest across the world is high, so research is ongoing. Findings from that research will be implemented as appropriate and practicable in Utah. The strongest control approach is to simply focus upon keeping AIS out of Utah or contained to areas already infested.

  Boaters launching in Utah within 30 days from being on an AIS infested water will be requested to self-certify pre-launch that they have either implemented a "do-it-yourself" decontamination protocol or a "professional" decontamination protocol. These are pre-launch requirements in the case of *Dreissenid* mussels.

  Boaters leaving infested waters in Utah (to date only Electric Lake is infested with zebra mussels, although Lake Powell is suspect or at least highly threatened with contamination by *Dreissenid* mussels) will be compelled to decontaminate their watercraft and equipment prior to launching on another water.

  Mitigation or restoration of damaged habitats is routine business for Utah Division of Wildlife Resources and its other natural resource management partners, as is the re-stocking of aquatic animals, when appropriate. Best management practices will be employed for every operation.

- **Monitoring and Evaluation Strategy:** Monitoring for invasions of AIS or spread of existing AIS is a significant challenge as compared to monitoring and evaluation for control and restoration work. Utah AIS Task Force members and agencies will keep track of invasions of AIS or spread of existing AIS, documenting change in conditions annually.

  Evaluation is for the most part, "cut and dry." "Did the Utah AIS Task Force successfully keep AIS out of Utah or contained to existing infested areas, and to what degree are control and restoration strategies successful?" Annual reports summarizing AIS work in Utah, including monitoring, will be coordinated and prepared by the Utah Division of Wildlife Resources and provided to the U.S. Fish and Wildlife Service's Regional AIS Coordinator (Erin Williams, U.S. Fish and Wildlife Service, Denver, CO) beginning in December 2008.

Utah's AIS Rapid Response Strategy

Much of Utah's AIS Management Plan is focused upon preventing new AIS from arriving and becoming established. However, another important function of this plan is a strategy for a coordinated rapid response to findings of newly imported AIS or to the spread of already established AIS. In the past, individual agencies worked virtually alone trying to intercept AIS. Heretofore findings of new or spreading invasions of AIS in Utah were often dependent upon chance, and more often than not, reported by an observant public. In the future, most findings of new or spreading AIS are anticipated to be a result of well executed searches, followed by a well planned, timely and coordinated rapid response to contain or control new or spreading AIS.

The Utah Aquatic Invasive Species Act, codified as Chapter 27 of Section 23 in the Utah Code and Rule R657-60 provides authority to Utah Division of Wildlife Resources in the event of infestation by a *Dreissena* species in part as follows:

1. To close ingress and/or egress at a water body, facility or water supply system to terrestrial or aquatic vehicles and equipment capable of moving *Dreissena* species for protection of Utah from their spread; and
2. To maintain the closure until an acceptable plan for containment and/or control of the *Dreissena* species is developed and implemented by the water body operator.

Thus, water body operators in Utah are being strongly encouraged to develop individual response plans prior to the need for rapidly addressing containment and/or control of *Dreissena* species or other AIS in the event of an unfortunate infestation. Pre-infestation assessments for vulnerability and response plans can be developed at a more leisurely pace as compared to rapidly responding to the new find of an AIS infestation.

It is not the intent of this rapid response strategy to limit a water body operator's individual processes for identifying vulnerability to an AIS infestation, or creativity in the development and implementation of a suitable plan for containment and/or control of the AIS. Rather, it is a guide comprised of logically ordered objectives about how a multi-based group of agencies and interested parties, including the water body operator and the Utah Division of Wildlife Resources, acting as a team could either become prepared prior to infestation by AIS or to rapidly respond upon detection. It is important to recognize that Utah Division of Wildlife Resources as per Rule R657-60-8 and R657-60-9 has approval authority for rapid response plans dealing with *Dreissenid* mussels.

The following protocols, which are objectives of the rapid response strategy, outline a reasonable response process; they were adapted in-part from Idaho's 2007 Aquatic Nuisance Species Plan and modified to suit Utah's needs and purposes.

Protocols for Rapid Response Strategy

• Immediately verify a reported AIS detection

• Upon verification for the presence of an AIS, immediately notify relevant local natural resource managers, pulling their technical personnel together as a "response team," and notify Utah's AIS Task Force

• The response team must immediately begin surveys to define the extent of an AIS infestation
• As the extent of infestation is being determined, set-up an appropriate command structure to guide continuing response team activities for determining and implementing containment and/or control methods for the AIS infestation
• Establish internal and external communication systems
• Organize available resources (personnel, equipment, funds, etc.), including compliance with laws and permitting requirements
• Prevent further spread using quarantine and pathway management
• Apply available, relevant and legally defendable eradication, control and/or containment actions and implement mitigation
• Institute long-term monitoring
• Evaluate response effectiveness, modify the Rapid Response Strategy as needed, and pursue long-term funding for AIS management

Rapid Response Objective 1: Immediately verify a reported AIS detection.

Strategy: Any person or agency that receives or accepts responsibility for handling the initial report for the presence of an AIS must immediately contact Utah Division of Wildlife Resources for assistance to begin appropriate processes to confirm a report's validity and to cause implementation of the rapid response strategy.

Note: In regards to Dreissena mussels, this strategy is required by law (R657-60-4).

Task 1: Immediately interview the reporter(s), which may be anyone from the public, or a microscopy lab, and/or a lab that conducts deoxyribonucleic acid polymerase chain reaction tests (PCR) on plankton or tissue samples received from a Utah Aquatic Invasive Species Task Force partner agency, to begin validation of the alleged AIS detection.

• A microscopy report from a lab, based upon morphological or histological characters of a suspect specimen living in nature, is considered as preliminary for the presence of *Dreissena*. Such a report must only be provided to Utah Division of Wildlife Resources' AIS Coordinator.

• Following a microscopy report, Utah Division of Wildlife Resources' AIS Coordinator will request that the microscopy lab forward a portion of the original sample for two different and independent molecular deoxyribonucleic acid polymerase chain reaction tests (PCR) for confirmatory assessment regarding the presence of *Dreissena*. Again, reports for findings from PCR labs must only be provided to Utah Division of Wildlife Resources' AIS Coordinator.

Note: Security regarding any lab report results from a need to control release of the information, minimizing speculation by the media, public and others about environmental or economic impacts, and eventual containment and control methods prior to full assessment of the finding. Additionally, action by the Utah Wildlife Board is required in order to list any water in Rule R657-60-2(2)(g) as infested with a *Dreissena* species.

• Record details of the AIS find location, such as GPS delineation, name of the water body or stream length number, prominent landmarks, highway mile marker, or other information about where the suspect species was found.

• Collect pertinent contact information for the reporter(s)--name, address, telephone (home, work and cellular), and email.
• Secure an estimate of the number of individuals or colonies, density and extent (e.g. acreage or linear miles of stream) for infestation of the species found.
• Document the date and time of sighting(s).
• Note other relevant site conditions (access limitations, etc.)

Task 2: When Utah Division of Wildlife Resources' AIS Coordinator first receives notification from either a microscopy lab or a PCR lab regarding a *Dreissena* finding, the AIS Coordinator will immediately contact the Director's office at Utah Division of Wildlife Resources' and the Fishery Chief. This group will immediately meet to make a decision about release of the information to appropriate partners (water body operators and the Utah AIS Task Force). Any release of information by the AIS Coordinator to partner groups must consider need and value for a coordinated release of information to the media. And, media advisories will be orchestrated and coordinated amongst the water body operators and the Utah AIS Task Force by Utah Division of Wildlife Resources' Outreach Chief.

Task 3: Validate AIS identification as soon as possible via a physical sample as follows:
• Obtain a digital or other photograph (with scale indicator), if possible.
• Secure and preserve dead samples of the species, if possible, for confirmation.
• Arrange an immediate site visit, when feasible, by a team of recognized experts.
• If recognized experts cannot feasibly reach the site within 24 hours, arrange to ship samples and other evidence (e.g., photographs) via Express Mail Service. In the case of photographs, use a digital camera or scan (digitize) 35 mm or printed photos and email them to the experts.

Note: Prior to shipping samples, obtain guidance from recognized experts, seeking existing protocols regarding handling of the sample (e.g. desired quantity, where and how to collect and deliver the sample, preservatives, refrigeration, etc.).

Rapid Response Objective 2: Upon verification for the presence of an AIS, and with concurrence of Utah Division of Wildlife Resources' Director, immediately notify relevant natural resource managers (local natural resource managers, Utah's AIS Task Force, and AIS Coordinators in adjoining states), pulling appropriate technical personnel together as a "response team."

Strategy: The agency that receives or accepts responsibility for handling the initial report for the presence of an AIS upon verification for the presence of an AIS, must immediately ensure that all parties having local jurisdiction and interest in response decisions or having technical support capabilities are quickly engaged as a "response team" as follows:

Note[1]: The "response team" at a minimum should be comprised of technical personnel from Utah Division of Wildlife Resources (AIS biologist); water body operator interests (local irrigation company's water master, water conservancy district and/or Bureau of Reclamation); local land management authority (private owners, Utah State Parks and Recreation, U.S Forest Service, and/or Bureau of Land

Management). Possibly, other personnel may be needed, depending on the complexity for dealing with the initial AIS finding, so the response team will determine need and secure additional expertise. Local irrigation companies and some water conservancy districts may elect to have a consultant firm's representative participate on their behalf or with them. Utah's AIS Task Force will serve as consultant and mentor for the "response team."

Note[2]: In the case of an interdiction where rapid response by a professionally trained responder results in complete destruction of the AIS (e.g. apprehension for unlawful transport of a live AIS); and when possible, a successful decontamination of the introduction vector (e.g. boat or equipment) ensues, file pertinent reports notifying the response team and the Utah AIS Task Force. No further coordination is needed.

Note[3]: Routine day-to-day operations for interdictions of boaters at water bodies and resultant decontaminations do not require notification of the "response team," although summary reports for seasonal activity must be prepared, filed and shared with the team and Utah's AIS Task Force.

Task 1: Within the first 24 hours or as soon as practical after a physical sample is visually confirmed to be an AIS by a recognized expert, notify Utah Division of Wildlife Resources (in the case of a *Dreissena* species this notification is required by Rule R657-60-4); notify and pull together a local "response team" of technical personnel; involve other relevant natural resource managers and interested publics to participate as determined by the team; advise Utah's AIS Task Force of the determination and planned future action.

Note: A local notification list must be maintained by Utah Division of Wildlife Resources' five regional AIS biologists and be updated at least twice annually. Utah Division of Wildlife Resources' AIS coordinator in Salt Lake City must be notified about any AIS finds; he will immediately notify the Utah AIS Task Force.

Task 2: Within the first 24 hours or as soon as practical inform any other interested parties (e.g. elected officials; organized, local recreational user groups; media via the Outreach Section as determined necessary by Utah Division of Wildlife Resources Director; etc.).

Task 3: Make verification of notifications to confirm that parties on the contact list, did in fact, receive notification (e.g., use Internet list server response confirmation or phone call-backs).

Rapid Response Objective 3: The response team must immediately begin surveys to define the extent of an AIS infestation.

Strategy: The response team must rapidly determine the extent of colonization for the newly discovered AIS to guide subsequent management decisions regarding containment and/or control.

Task 1: Identify within the response team a lead monitoring coordinator, determine accepted survey methods, and pool resources to maximize the effectiveness of survey efforts.

Task 2: The response team must immediately survey water bodies to determine the geographic extent and population demographics of an AIS infestation. Include

upstream and downstream areas, connected water bodies, and nearby water bodies having potential vulnerability to the original or latent contamination pathways.

Task 3: Immediately identify and make arrangements to survey any potential facilities (e.g., hydropower, fish hatcheries, irrigation systems, etc.) that could be impacted by the AIS, advising their operators of the predicament and invite them to become engaged as cooperators with the "response team."

Task 4: Ensure that surveys are completed as soon as possible and that results are reported to the entire "response team," other interested parties, and the Utah AIS Task Force.

Rapid Response Objective 4: As the extent of infestation is being determined, set-up an appropriate command structure to guide continuing response team activities for determining and implementing containment and/or control methods for the AIS infestation.

Strategy: As the extent of AIS infestation is becoming known, supervisory leadership for the response team members needs to immediately meet, making assignment amongst their staffs for a continuing response and commitments for other needed resources. Continuing efforts to contain and/or control the AIS infestation could occur under the framework of the National Incident Command System or any other mutually agreed upon personnel management scenario to facilitate command and decision-making processes. Nonetheless, concurrence amongst the supervision for the response team members must be achieved about how to proceed in order to expedite conduct of work, avoid duplication of effort, facilitate public outreach and information sharing between agencies, minimize authority conflicts, while preserving flexibility for adaptive management.

Task 1: Supervisory leadership for the response team members must achieve concurrence for appointment of an incident commander to lead the response team in developing and implementing an AIS containment and/or control plan.

Note[1]: Where multiple agencies have shared jurisdiction over a water body (e.g. Bureau of Reclamation water management operations and U.S. Forest Service recreational and land management operations), a unified command structure with co-lead incident commanders may be used.

Note[2]: Likely an incident commander will originate from a state or federal natural resource management agency having jurisdiction over the infested water and surrounding recreation area. An incident commander should currently hold a leadership position allowing for the necessary time commitment and experience to lead a multi-agency response team.

Note[3]: The incident commander will be the voice to represent the response team, and will direct and coordinate development and implementation of a rapid response to contain and/or control an AIS infestation.

Note[4]: In the event there is no initial consensus on the incident command role, this role will default to the UDWR statewide AIS Coordinator and/or the appropriate U.S. Fish and Wildlife Service Regional AIS Coordinator until the relevant water body/recreation area operation authorities achieve concurrence on incident command.

Task 2: The incident commander shall convene a meeting involving the response team and conduct the following:
• Facilitate a decision-making process that uses consensus building and recognizes existing, cascading levels of authority within individual agencies, along with existing cooperative agreements;
• Establish organizational assignments within the response team as needed (e.g. outreach, budget & inventory control, etc.), including an assessment of need for additional representation on the response team by local, tribal, state, federal governments entities, including non-governmental organizations;
• Establish process for response team notifications, schedule of necessary meetings and a priority of activity, including realistic timelines/deadlines;
Task 3: The incident commander should develop a technical advisory team that includes experts from outside the local area to provide advice about planned response team activities and priorities.
Note: Distal members or others on technical advisory team do not necessarily have to assemble onsite, but can provide guidance to the incident commander and the response team via telephone conference calls involving the entire technical advisory team.

Rapid Response Objective 5: Establish internal and external communication systems.

Strategy: The Incident Commander and the response team must develop an information dissemination process to ensure consistent and effective communication to interested internal and external stakeholders, including the media and public.

Task 1: Notify and educate affected landowners, and where appropriate, gain their written permission to access property for response team activities.
Task 2: Notify and educate potentially affected water users and water-rights holders.
Task 3: Develop a public information strategy, press packets, press release processes, and press conferences.
Task 4: Develop and implement general public education and outreach.
Note[1]: Since there are a variety of AIS educational materials used between regions and states, assure coordination during a multi-state infestation, and perhaps agreement on materials to be used.
Note[2]: Regarding tasks 3 & 4, assistance from a professional outreach staff member from one of the response team agency's should be sought, since they have expertise and previously established liaison with local and statewide media resources and personalities.

Rapid Response Objective 6: Organize available resources (personnel, equipment, funds, etc.), including compliance with laws and permitting requirements.

Strategy: The Incident Commander and the response team must identify and secure sufficient resources to affect AIS eradication, control and/or containment actions, including recognition for need to comply with a broad array of local, state and federal laws and permitting processes.

Task 1: Develop estimates and identify potential sources for the response team's needs regarding staff, facilities, equipment and funds.

Task 2: Secure commitment from the response team's home agencies and others for needed staff, facilities, equipment and funds.

Task 3: Ensure mechanism for dispersal of funds is in place, and when the funds are needed, that the flow of dollars occurs expeditiously, including inventory control for acquired equipment.

Task 4: Arrange for the response team to be briefed about the array of local, state and federal laws that pertain to the activities in which they may engage to achieve AIS eradication, control and/or containment (e.g. National Environmental Policy Act considerations regarding need for environmental statements, assessments and prior approved actions recognized as categorical exclusions, including need for associated mitigation; Endangered Species Act consultations and compliance; etc.).

Task 5: Arrange for the response team to be briefed about the array of local, state and federal permits that may be needed to conduct the activities in which they may engage to achieve AIS eradication, control and/or containment (e.g. pesticide applicator permit; National Pollutant Discharge Elimination System permits administered by the Environmental Protection Agency and the Utah Department of Environmental Quality; etc.).

• Consider any applicable emergency provisions associated with permits (e.g. Federal Insecticide, Fungicide and Rodenticide Act, Federal Crisis Exemption--40 C.F.R. PART 166--can be secured if the known or accepted methods of eradication are not currently permitted);

• Keep in mind that state and national permits under some programs already exist (e.g. state stream alteration permits administered by Utah Division of Water Rights, section 404 Clean Water Act dredge and fill permits administered by the Army Corps of Engineers; etc.) and

• Assess modifying existing agency permits for needed purposes as opposed to securing a new permit

Task 6: If reasonable and necessary, pursue declarations of emergency by elected officials.

Rapid Response Objective 7: Prevent Further Spread Using Quarantine and Pathway Management.

Strategy: The Incident Commander and the response team in coordination with agencies having regulatory authority must minimize all vectors and pathways that might further spread the original infestation.

Task 1: Evaluate risks for dispersal vectors and pathways for further spreading the AIS, including movement by human activity, construction, water-haul and recreational equipment, movement by fish and wildlife, movement via water flow, and other physical processes.

Task 2: Restrict dispersal vectors and pathways, where feasible, including the following or similar measures that are suitable for individual species:

• Under authority of Rule R657-60-8, consider closure of infested water bodies, facilities, or water supplies, as needed, to prevent spread of *Dreissenid* mussels by human activity, construction, water-haul and recreational equipment, movement by fish and wildlife, movement via water flow, and other physical processes;

• Assess the likely movement patterns of boats that recently used the infested water body to identify risk and inspection needs at other water bodies;
• Establish inspection requirements and decontamination protocols for boats and equipment, and provide decontamination opportunity;
• Ensure that AIS "alert" signs are adequately deployed;
• Develop and implement Hazard Analysis and Critical Control Point plans to ensure that private and local, state, tribal or federal government response personnel do not further spread the original infestation;
• If possible, stop or slow water releases to potentially non-infested sites;
Note: Consider making water draws from below the thermocline; and
• Install physical barriers, if possible, to affect AIS movement (e.g. migration barriers to fish populations that harbor whirling disease, keeping them out of non-infested areas).

Rapid Response Objective 8: Apply available, relevant and legally defendable eradication, control and/or containment actions and implement mitigation.

Strategy: The Incident Commander and the response team must evaluate management options for eradication, control and/or containment of the AIS, and then proceed, including implementation of suitable mitigation.

Task 1: Decide whether eradication, control and/or containment is possible based on rapid analysis of population dynamics, extent of distribution and analysis of vectors and pathways for AIS spread and available management options. Consider the following:
• Anticipated cost of eradication effort and follow-up monitoring relative to available funding;
• Type of water body (e.g. lake, main-stem reservoir, tributary reservoir, small stream, large river, wetland, or water diversion facility);
• Type of substrate (e.g., rocks that allow species attachment on their under sides where chemicals may not reach them);
• Extent of population distribution (isolated vs. widespread, coupled with *a priori* assumptions about the spread of the AIS before detection);
• AIS life stage(s) to be treated; and
• Volume of water in a lake, reservoir or waterway to be treated, considering the following:
1. Potential for the lake or reservoir to be drawn down or river flows to be reduced before treatment; and
2. Inflow sources, including springs, and potential to regulate that inflow.
• Assess circulation patterns in a water body as part of the treatment strategy;
• Determine known or potential spreading pattern of AIS population within the water body;
• Review known protocols for controlling and/or containing individual AIS species identified in Appendix A (documented August 2008);
• Review literature and consult experts for new or emerging methodology
• Assess treatment impacts and needed mitigation, particularly in regards to cultural resources, state protected or sensitive species, high valued habitats, federally listed threatened or endangered species or listed critical habitats; and

• Consider special status of affected water bodies as follows:
1. Water use designation (e.g. drinking water and other beneficial uses);
2. "Wild and Scenic" river designation;
3. Wilderness area designation;
4. Department of Defense or other restricted access areas;
5. Private, state, federal or tribal lands; and
6. Clean Water Act section 303(d) listing.

Task 2: Obtain relevant permits and regulatory agency support or concurrence for planned actions facilitating AIS eradication, control and/or containment methods, including agreed upon mitigation.

• Identify the lead contact within each regulatory agency who will facilitate permit approval, staying in touch until the permit or letter of authorization is issued;

Task 3: Implement appropriate eradication, control and/or containment methods using adaptive management approaches as appropriate.

Task 4: Consider funding research and development efforts to find new eradication, control and/or containment methods.

Task 5: Implement agreed upon mitigation.

Rapid Response Objective 9: Institute Long-Term Monitoring.

Strategy: The Incident Commander and the response team must collect and document data from long-term monitoring of the AIS infestation, including the post treatment period.

Task 1: Design and conduct a project-specific and long-term monitoring program to evaluate the status of the AIS infestation. Include the post treatment period as it relates to effectiveness of treatment or non-treatment.

Note: Every monitoring project will be uniquely different in terms of AIS, location and sampling periodicity, although methodologies for biological monitoring of aquatic populations and aquatic habitats are relatively standardized.

• Monitoring of the AIS infestation can be carried out in coordination with other field operations, such as monitoring to meet permit or other regulatory compliance resulting from eradication, control and/or containment actions or monitoring for mitigation effectiveness.

Task 2: Disseminate findings through an easily accessible, consolidated, coordinated real-time database and list serve (e.g. 100th Meridian Initiative's website).

Rapid Response Objective 10: Evaluate response effectiveness, modify the Rapid Response Strategy as needed, and pursue long-term funding for AIS management.

Strategy: The Incident Commander and the response team, in order to allow for adaptive management by assuring feedback on the efficacy of response actions and the effectiveness of the Rapid Response Strategy, can enhance long-term preparedness for responses to other AIS introductions.

Task 1: Conduct a follow-up evaluation by response team organizations and other interest groups to identify opportunities for improving the Rapid Response Strategy. Disseminate "lessons learned" to other interested organizations (e.g.

states, national Aquatic Nuisance Species Task Force, 100th Meridian Initiative, Regional Panels and River Basin teams).

Task 2: Revise the Rapid Response Strategy and associated documents/guidelines based on evaluation and long-term monitoring results.

Task 3: As resources allow, develop and implement an assessment that evaluates the associated ecological and economic impacts of the AIS invasion, the effectiveness of management interventions, and negative consequences of management interventions beyond that required by permits.

Task 4: Determine the need for long-term funding for the current AIS management effort, and seek this funding as warranted by meeting with state and federal legislators.

Literature Cited

Dalton, Larry B. 2003. Fishing License Marketing Plan. Utah Division of Wildlife Resources, unpublished report.

Dalton, Larry B. 2005. Fishing License Marketing Summary 2003-2005. Utah Division of Wildlife Resources, unpublished report.

Harris, Dave. 2008. Calculated estimate from a web boating expenditure calculator. Utah State Parks and Recreation unpublished report.

O'Neill, C.R., Jr. 1996. The Zebra Mussel—Impacts and Control. New York Sea Grant. Cornell University, State University of New York, Cornell Cooperative Extension. Information Bulletin 238. 62pp.

The Institute for Outdoor Recreation and Tourism, Utah State University. 2007. Recreational Water Use Issues and Regional Planning on Utah's Lakes and Reservoirs and 2006 Utah State Park Boating Survey: Comparison with Previous Studies.

Southwick Associates, Inc. 2007. The 2006 Economic Benefits of Hunting, Fishing and Wildlife Watching in Utah.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 1991. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 1996. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2001. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2006. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

Appendix A

Aquatic Invasive Species That Threaten Utah

Aquatic invasive species (AIS) are not strangers to Utah. In fact, many AIS now inhabit Utah and others threaten the state with immediate arrival. The list frequently grows with discoveries of new AIS, presenting new threats and challenges for natural resource managers. Several new and potential AIS are being further assessed--the amphibian bacterium redleg *Aeromonas hydropila*, with a potential statewide distribution; the Chinese mysterysnail *Cipangopaludina chinensis* in central Utah; the Pacific treefrog *Pseudacris regilla* and their relatives possibly in northern (Raft River Mountains) Utah and recently re-introduced into southern Utah (Washington County); the spiny softshell *Apalone spinifera* in the Virgin River of southern Utah, all pond sliders *Trachemys spp*. and cooters *Pseudemys spp*. with potential statewide distributions, and the snapping turtle *Chelydra serpentina* in northern and central Utah. Other species being assessed as AIS, and also not included in this plan are the flathead catfish *Pylodictis olivaris*, currently found in Arizona; the jaguar quapote *Cichlasoma managuense*, which is an aquarium discard; rainwater killifish *Lucania parva*, which arrived via game fish transplants from the mid west; goldfish *Carassius auratus*, which are a widespread aquarium discard; common carp *Cyprinus carpio*, which was introduced as a food source in the late 1800s into Utah County by the agency now known as the U.S. Fish and Wildlife Service; red shiner *Cyprinella lutrensis*, which was initially stocked as a game fish forage crop by Utah Division of Wildlife Resources, but now severely limits recovery of endemic fish in the Virgin River; golden shiner *Notemigonus crysoleucas*, which was also initially stocked as a game fish forage crop by Utah Division of Wildlife Resources; and fathead minnow *Pimephales promelas*, which was stocked into Utah Lake by Utah Division of Wildlife Resources as a game fish forage crop. None of the above are presented as a species profile in the biographic accounts for this plan; they represent AIS determinations that will occur as the plan is re-assessed during its first five years (2009-2013).

Aquatic pathogens (e.g. viral hemorrhagic septicemia, cold water disease, whirling disease, Asian tapeworm *Bothriocephalus acheilognathi*, and the trematode *Centrocestus formosanus,* etc.) are also considered as AIS, but are not included in the individual AIS species accounts contained within this plan. Aquatic pathogen control is managed by the Utah Department of Agriculture and Food.

AIS are exotic species to Utah and aggressively compete with our native flora and fauna. They frequently have longer evolutionary histories than native biota, which makes AIS more effective competitors that are capable of securing vacant niches. AIS typically have few if any natural predators. And, AIS result in economic impacts to the State of Utah.

The AIS list for this plan currently includes fungi, algae, plants, mollusks, crustaceans, fish, amphibians and reptiles. Biographic accounts for individual AIS follow; they are ordered in a phylogenetic progression with species arranged alphabetically by their most

accepted common name. The accounts are not intended to be complete documentations of what science knows about each species. Rather, they will serve as a quick ready reference for day-to-day management discussions amongst Utah's AIS staff and others. The Internet, professional periodical publications, "white and grey" agency papers, and journals for various societies remain the core for more detailed, in-depth literature research. Each account includes discussion about the species ecology; distribution in Utah, including a map; pathways of introduction; management considerations; and citations to the literature used to develop the account.

The aforementioned list for potential AIS and the following biographic accounts for known AIS were compiled by Utah Division of Wildlife Resources' Aquatic Invasive Species Personnel and others as follows:

Larry Dalton, Aquatic Invasive Species Program Coordinator
Candace Hutchinson, Aquatic Invasive Species Biologist—Northern Region
Evan Freeman, Aquatic Invasive Species Biologist—Central Region
Crystal Stock, Aquatic Invasive Species Biologist—Southern Region
Natalie Muth, Aquatic Invasive Species Biologist—Northeastern Region
Daniel Keller, Aquatic Invasive Species Biologist—Southeastern Region
George Oliver, Natural Heritage Program Ecologist
Jenny Polloczek, Aquatic Invasive Species Consultant

Author's Note: Jenny served as the Northern Region's Aquatic Invasive Species Biologist during the plan's initial preparation; after which she performed as a private consultant during final editing.

AIS addressed in this plan that are currently considered to threaten Utah follow:

AIS_11a Chytrid (PDF)
AIS_11b Didymo (PDF)
AIS_11c Common Reed (PDF)
AIS_11d Curly-leaf Pondweed (PDF)
AIS_11e Eurasian Watermilfoil (PDF)
AIS_11f Purple Loosestrife (PDF)
AIS_11g Tamarisk (PDF)
AIS_11h Asian Clam (PDF)
AIS_11i Dreissenid Mussels (PDF)
AIS_11j New Zealand Mudsnail (PDF)
AIS_11k Red-Rimmed Melania (PDF)
AIS_11l Crayfish (PDF)
AIS_11m Burbot (PDF)
AIS_11n Gizzard Shad (PDF)
AIS_11o Western Mosquitofish (PDF)
AIS_11p Green Frog (PDF)
AIS_11q North American Bullfrog (PDF)
AIS_11r Plains Leopard Frog (PDF)
AIS_11s Rio Grande Leopard Frog (PDF)
AIS_11t Red-eared Slider (PDF)

FUNGI

Chytrid Fungus *Batrachochytrium dendrobatidis*
Ecology: Chytrid fungus is responsible for a deadly amphibian disease known as Chytridomycosis. The spores of this fungus attack the keratin in frog skin affecting their ability to breathe and absorb water through their skin. These fungal spores can also damage the nervous system of the amphibian, affecting the frog's behavior (New South Wales Government, Department of Environment and Climate Change 2008).

Chytrid fungi typically live in water or soil, although some are parasites of plants and insects. They reproduce asexually and have spores that "swim" through the water. Only the amphibian chytrid fungus is known to infect vertebrate species. Individual frogs are thought to contract the disease when their skin comes into contact with water that contains spores from infected animals (Australian Natural Heritage Trust 2004).

There are several signs to look for when trying to determine if you have an effected frog. Symptoms relating to the skin include: discoloration, peeling or sloughing of the outer layers of the skin, and rough texture. Another characteristic of infected frogs' is their inability to hold their limbs close to their bodies. In extreme cases, the frog's legs actually trail behind the body. Infected individuals are typically sluggish and show a loss of appetite. Once infected, they will remain in the open, exposing them to an increased risk of predation (New South Wales Government, Department of Environment and Climate Change 2008).

Distribution: The Chytrid fungus is thought to have originated in South Africa, and was originally spread through the commercial trade of the African clawed frog *Xenopus laevis (*Amphibian Ark 2007). The basis for this conclusion is due to a specimen in a South African museum dating to the 1930's. This fungus is found worldwide. It is presently found in Australia; Africa; North, Central and South America; Europe; New Zealand; and Oceania (Australian Natural Heritage Trust 2004). It is found the across the United States (Ouellet et al. 2004), including across all of Utah (Pers. Comm. Krissy Wilson, 2008. Native Aquatic Program Coordinator, Utah Division of Wildlife Resources).

Pathways of Introduction: The means of introduction of Chytrid fungus into the United States is unknown. The earliest North American record was found in a leopard frog *Rana pipiens,* collected in 1974 (Speare and Berger 2000). There are several known vectors that can spread the fungus. Humans are a major factor in the spread of this fungus, since recreationists can pick up the fungus unknowingly from an infested area and transport it to a new area on equipment (New South Wales Government, Department of Environment and Climate Change 2008). Migratory birds and other animals can also transport the spores to new sites after picking up the spores in infected waters (Mendelson et al 2006). The frogs, themselves, act as vectors, moving the spores to new waters as they travel throughout their range (Mendelson et al 2006).

Management Considerations: There is no known method to eradicate Chytrid fungus in the wild. Decontamination of equipment coming in contact with infested waters is the

best practice in helping to halt its spread. Spraying down all equipment with 409 cleaner and then letting it dry in the sun effectively kills the spores (Watry 2006).

.

Literature Cited:

Amphibian Ark. 2007. Chytrid fungus. Available: www.amphibianark.org/chytrid.htm. (August 2008).

Australian Natural Heritage Trust. 2004. Chytridomycosis (amphibian chytrid fungus disease). Available: www.environment.gov.au/biodiversity/invasive/publications/c-disease/index.html. (January 2008).

Cann, A.J. 2006. MicrobiologyBytes: Chytrid fungus. Available: http://microbiologybytes.wordpress.com/2006/09/. (February 2008).

Mendelson JR, Lips KR, Gagliardo RW, Rabb GB and 50 others. 2006. Confronting amphibian declines and extinctions. Science 2006: 313:48.

New South Wales Government, Department of Environment and Climate Change. 2008. Frog Chytrid Fungus. Available: www.environment.nsw.gov.au/plantsanimals/FrogChytridFungus.htm. (February 2008).

Ouellet, M., Mikaelian, I., Paulie, B. D., Rodrigue, J., and Green, D. M. 2005. Historical evidence of widespread Chytrid infection in North American amphibian populations. Conservation Biology 19: 1431- 1440.

Speare, R. and Berger L. 2000. Global distribution of chytridiomycosis in amphibians. Available:www.jcu.edu.au/school/phtm/PHTM/frogs/chyglob.htm. (August 2008).

Watry, M. K. 2006. Guidelines for prevention of introduction and spread of aquatic threats by cleaning and disinfecting fishing and field equipment. Available: www.nps.gov/romo/planyourvisit/upload/aquatic_guidelines2006.pdf (August 2008).

ALGAE

Didymo (Rock Snot) *Didymosphenia geminata*

Ecology: *D. geminata* is a diatom, which is a type of single-celled algae. Diatoms are extraordinary organisms, unique for their silica (SiO^2) cell walls (Spaulding 2007). Diatoms are found in nearly every freshwater and marine aquatic habitat, and supply a large percentage of the global carbon budget through photosynthesis. *D. geminata* is made up of cells that cannot be seen with the naked eye until large colonies form. Only one of these cells needs to be transported for the algae to spread (Biosecurity NZ 2005). In both oceans and freshwaters, diatoms are one of the major groups of organisms within the plankton (including other algae, bacteria and protozoa) and also grow attached to surfaces.

The life history of diatoms includes both vegetative and sexual reproduction (Edlund and Stoermer 1997) *D. geminata* cells possess a raphe, a structure that allows the cells to move on surfaces. The cells also have an apical porefield, through which a mucopolysaccaride stalk is secreted. The stalk may attach to rocks, plants, or any other submerged substrate (Kilroy 2004). It is not the diatom cell itself that is responsible for the negative impacts of *D. geminata*, but the massive production of extracellular stalk. Extracellular polymeric substances that comprise the stalk are largely composed of polysaccarides and protein. They are complex, multi-layered structures that are resistant to degradation (Spaulding 2007). The environmental factors that initiate stalk production are unknown; however, understanding the mechanisms of stalk production is crucial for determining ecological impacts and control of *D. geminata* (Spaulding 2007).

Distribution: Known locations in Utah include: Cottonwood Gulch Creek below Joes Valley Reservoir on the Manti LaSal National Forest (Pers. Comm. Paul Birdsey. 2008. Southeastern Region Aquatic Program Manager, Utah Division of Wildlife Resources), and Rock Creek below Upper Stillwater Reservoir on the south slope of the Ashley National Forest (Pers. Comm. Roger Sneidervin. 2008. Northeastern Region Aquatic Program Manager, Utah Division of Wildlife Resources). Unfortunately, *D. geminata* is broadly distributed in North American (Figure 1) (Spaulding 2007), particularly in the West.

Pathways of Introduction: The mechanisms for *D. geminata*'s expansion into new watersheds are not well understood. Early suggestions that increases in UV-B radiation was tied to the expansion of this species were not supported (Sherbot & Bothwell 1993; Wellnitz et al. 1996; Rader and Belish 1997). Recent work illustrates the capacity of *D. geminata* to survive outside of the stream environment as well as potential vectors in its spread. Cells are able to survive and remain viable in cool, damp, dark conditions for at least 40 days (Kilroy 2005). Fishing equipment, boot tops, neoprene waders, and felt-soles in particular, all provide sites where studies have shown cells remain viable (Kilroy et al. 2006). At the same time, traveling to distant destinations for fishing trips is becoming more common. Rather than returning to a favorite local fishing site, anglers travel to multiple and often distant destinations for fishing vacations.

The arrival of *D. geminata* in New Zealand, in 2004, indicates that it most likely arrived via human-assisted means, such as: on footwear, fishing equipment, boats, etc. (Kilroy

2004).

It is also possible for clumps of *D. geminata* to pass through the guts of birds or other animals, or on the feet or feathers/fur of birds and animals (Atkinson 1980; Kociolek and Spaulding 2000; Kilroy 2004). Wind dispersal of mucilaginous material (the stalks) of *D. geminata* could also occur over short distances (Kilroy 2004).

Management Considerations: *D. geminata* is considered invasive in the United States, since the diatom's blooms cause economic impacts. The human population of the western United States is dependent on a system of canals and pipelines to transport water for hydropower generation, agriculture, and human consumption. Nuisance algae, including *D. geminata*, regularly thrive on the stable substrate and flow regime of canal systems (Pryfogle et al. 1997). In some canal systems, managers implement regular removals by scraping *D. geminata* growths from the concrete surfaces of canals.

D. geminata is often reported by recreationalists to land managers as being unattractive. The stalks are often mistaken for raw sewage, leading homeowners and recreationalists to complain to local water treatment plants. Many communities rely on tourism dollars that are generated by outdoor recreation. Natural resource opportunities represent important economic value, yet they may be vulnerable to damage by the spread of this nuisance species.

Studies on the effects of *D. geminata* on native New Zealand fish are in progress. Large amounts of non-nutritious stalk material present on stream substrates are predicted to have harmful effects on native fish. Fish that are dependent on benthic habitat are expected to receive the greatest impact (Larned et al. 2006). If the favored food sources for fish are impacted in a negative way, fish will also be impacted negatively. In New Zealand *D. geminata* has been correlated to increases of invertebrates that are indicators of poor stream health (Larned et. al. 2006).

As with any aquatic invasive species, an aggressive education and outreach program is necessary to change water user's behavior in order to minimize their spread. A public campaign designed to educate anglers, boaters, professional guides, and other recreationalists must be integrated with existing invasive species programs. Freshwater resource users, including water managers, fisheries biologists, and other scientists, need to be aware of the threat and should practice proper decontamination of their equipment to help stop the spread of *D. geminata.*

New Zealand is pursuing a series of experimental trials of biocides for possible control of *D. geminata* within its streams and rivers (Jellyman et al. 2006). Preliminary data from these trials indicate that chelated copper may be effective in controlling *D. geminata.*

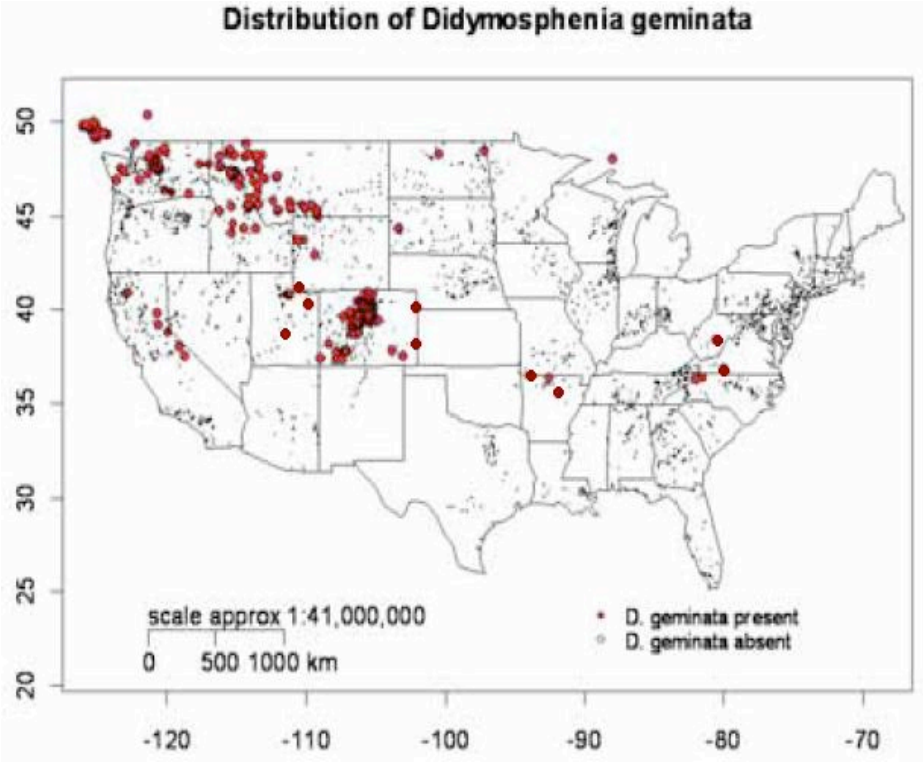


Figure 1.

Literature Cited:

Atkinson, K.M. 1980. Experiments of dispersal of phytoplankton by ducks. British Phycological Journal 15: 49-58.

Bio Security, New Zealand. 2005. The Ministry of Agriculture and Forestry, New Zealand. Available: www.biosecurity.govt.nz/didymo (March 2008).

Edlund**,** M.B. and E.F. Stoermer. 1997. Ecological, evolutionary, and systematic significance of diatom life histories. Journal of Phycology 33:897-918

Jellyman, P.G., S.J. Clearwater, B.J.F. Biggs, N. Blair, D.C. Bremner, J.S. Clayton, A. Davey, M.R. Gret, C. Hickey and C. Kilroy. 2006. *Didymosphenia geminata* experimental control trials (product screening and testing) and stalk degradation studies. NIWA Client Report: CHC2006-128, NIWA Project MAF06504.

Kilroy, C. November 2004. A new alien diatom, Didymosphenia geminata (Lyngbye) Schmidt: its biology, distribution, effects and potential risks for New Zealand fresh waters. Available: http://www.biosecurity.govt.nz/files/pests/didymo/didymo-preliminary-org-ia-nov-04.pdf (September 2008).

Kilroy, C. 2005. Tests to determine the effectiveness of methods for decontaminating materials that have been in contact with *Didymosphenia geminata*. National

Institute of Water and Atmospheric Research, New Zealand. Client Report: CHC2005-005, NIWA Project MAF05501.

Kilroy, C., A. Lagerstedt, A. Davey and K. Robinson. 2006. Studies on the survivability of the exotic, invasive diatom *Didymosphenia geminata* under a range of environmental and chemical conditions. NIWA Client Report: CHC2006-116, NIWA Project MAF06506.

Kociolek, J.P. and S.A. Spaulding (2000), Freshwater diatom biogeography Nova Hedwigia 71: 223-241.

Larned, S., Biggs, B., Blair, N., Burns, C., Jarvie, B., Jellyman, D., Kilroy, C., Leathwick, J.,Lister, K., Nagels, J., Schallenberg, M., Sutherland, S., Sykes, J., Thompson, W., Vopel, K., and Wilcock, B. 2006. Ecology of *Didymosphenia geminata* in New Zealand: habitat and ecosystem effects – Phase 2. NIWA Client Report CHC2006-086, NIWA Project MAF06507.

Pryfogle, P.A., B.N. Rinehart and E.G. Ghio. 1997. Aquatic plant control research. Idaho National Engineering Laboratory, DE-AC07-94ID13223.

Rader, R.A. T.A. Belish, 1997. Effects of ambient and enhanced UV-B radiation on periphyton in a mountain stream. Journal of Freshwater Biology 12:615-628.

Sherbot and Bothwell. 1993. A review of the ecology of *D. geminata* the physicochemical characteristics on Vancouver Island. NHRI Cont. No. 93005. Environ. Canada, Saskatchewan

Spaulding, S. 2007. Increase in nuisance blooms and geographic expansion of the freashwater diatom D. geminata. Available: www.epa.gov/region8/water/didymosphenia/White%20Paper%20Jan%202007.pdf (September 2008).

Wellnitz, T.A., R.B. Rader, and J.V. Ward. 1996. Importance of light and nutrients in structuring an algal community in a Rocky Mountain Stream. Journal of Freshwater Biology 11:399-413.

Photo by Sarah Spaulding, USGS and EPA

Didymo covers approximately 50 percent of the substrate in this image from Rock Creek, Utah.

PLANTS

Common Reed *Phragmites australis*

Ecology: *P. australis*, better know locally as *Phragmites* or common reed, is a tall, perennial, sod forming grass or reed (Uchytil 1992; Amsberry et al. 2000). Long pointed leaves grow from thick vertical stalks and flowers form dense clusters that create a plume-like flower head tawny in color (ISSG 2006). The common reed forms dense monodominant stands along marshes and shorelines (Uchytil 1992). These dense stands of tall reeds crowd native plants, displace native wetland vegetation and alter nutrient cycling (Saltonstall 2002; Windham and Ehrenfeld 2003). These changes alter the structure and function of some marshes and can threaten wildlife populations (Roman et al. 1984).

The common reed reproduces both by seed and vegetative means. Seeds are dispersed by wind and water and can persist in the marsh following a draw down as part of the seed bank. Most reproduction, however, is vegetative through the use of an extensive network of rhizomes and stolons (Smith and Kadlec 1983).

Distribution: *Phragmites* is native to North America and found in every U.S. state (U.S. Army Corps of Engineers 2004). The rapid increase of *Phragmites* in North American wetlands, however, is due to colonization by a more aggressive European variant of the plant (Saltonstall 2002). *Phragmities* is now common to wetland areas and canals throughout most of Utah (USDA, NRCS 2008) and is known to inhabit all counties in Utah.

Pathways of Introduction: Once established, *Phragmites* spreads rapidly by means of rhizomes or stolons (Uchytil 1992). *Phragmites* can spread up to 15 or 20 feet per year from vegetative spread alone. The flooding of the Great Salt Lake in the 1980's is believed to be an important factor in the dramatic increase of *Phragmites* around the eastern shore of the Great Salt Lake (Pers. Comm. Val Bachman. 2008. Waterfowl Management Area Superintendant, Utah Division of Wildlife Resources). Increased physical disturbances in marshes can initiate and accelerate expansion such as disturbances by foot traffic and floating debris (Amsberry et al. 2000).

Management Considerations: Currently there are 26 herbivores in North America known to attack *P. australis* (Tewksbury et al., 2002). Only five of these herbivores are believed to be native. Within this group only the Yuma skipper *Ochlodes yuma*, a dolichopodid fly in the genus *Thrypticus*, and a gall midge *Calamomyia phragmites*, are considered native and monophagous on *P. australis* (Tewksbury et al. 2002). Possible biocontrol species are being tested, but are not currently available (Blossey 2003).

Only mechanical and chemical control methods are available at this time for management of *Phragmites*. Mechanical control includes plowing, crushing, mowing, dredging and burning. Mechanical control methods that break up plant matter should be used with caution as they have the potential to increase vegetative spread. Prescribed burning can be successful only if root burn occurs. Burning is recommended during the summer when

carbohydrate reserves in the plant are low and when the soil is dry for maximum root burn (Uchytil 1992). Burning removes accumulated *Phragmites* leaf litter, allowing the seeds of other species adequate area to germinate (Marks et al. 1993). Complete removal of *Phragmites* by burning alone, however, is difficult and the practice is typically coupled with herbicide treatment and/or water draw downs.

The U.S. Army Corps of Engineers suggests a glyphosphate such as Rodeo® or Imazapyr Arsenal® as possible herbicide control. Rodeo® should be applied during late summer or fall when plants are actively growing and in full bloom. Arsenal® is nonselective and will kill other desirable plants. The 2, 4-D herbicides (SEE 2, 4-D, Weed Rhap A-6D, and Weedar 64) are also registered for use on canals or ditch banks in Utah (U.S. Army Corps of Engineers 2004). The Utah Division of Wildlife Resources is actively using a combination of glyphosphate herbicides and prescribed burning to control *Phragmites* along the eastern shore of the Great Salt Lake.

Literature Cited:

Amsberry, Lindsay, Michael A. Baker, Patrick J. Ewanchuk, and Mark D. Bertness. 2000. Clonal integration and the expansion of *Phragmites australis*. Ecological Applications 10(4):1110-1118.

Blossey, B. 2003. *Phragmites*: common reed. Ecology and Management of Invasive Plants Program. Available:http://www.invasiveplants.net/biologicalcontrol/9CommonReed.html. (February 2008).

ISSG (Invasive Species Specialist Group). 2006. Ecology of *Phragmites australis*. Global Invasive Species Database. Available: http://www.invasivespecies.net/database/species/ecology.asp?si=301&fr=1&sts=sss. (February 2008).

Marks, M., B. Lapin, and J.M. Randall. 1993. Element stewardship abstract for *Phragmites australis*. The Nature Conservency, Arlington, Virginia.

Saltonstall, K. 2002. Cryptic invasion by a non-native genotype of the common reed, *Phragmites australis*, into North America. Proceedings of the National Academy of Sciences of the United States of America 99(4):2445-2449.

Smith, L. M., and J. A. Kadlec. 1983. Seed banks and their role during drawdown of a North American marsh. The Journal of Applied Ecology 20(2):673-684.

Tewksbury, L., R. Casagrande, B. Blossey, P. Haflinger, and M. Schwarzlander. 2002. Potential for biological control of *Phragmites australis* in North America. Biological Control 23(2):191-212.

U.S. Army Corps of Engineers. 2004. *Phragmites australis* (Cav.) Trin. ex Steud. (common reed). Noxious and Nuisance Plant Management Information System. Available: http://el.erdc.usace.army.mil/pmis/. (February 2008).

Uchytil, R.J. 1992. *Phragmites australis*. Fire Effect Information System. Available: http://www.fs.fed.us/database/feis/plants/graminoid/phraus/all.html. (February 2008).

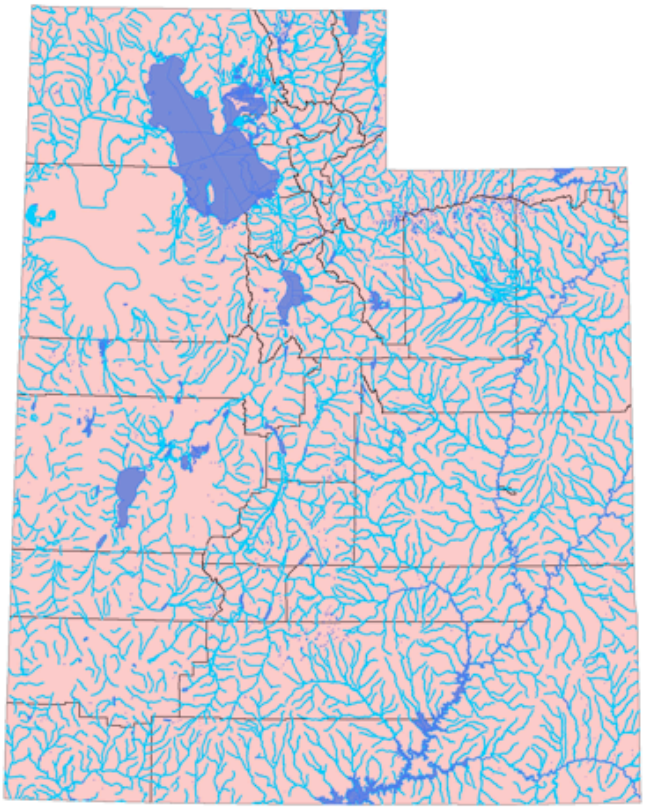
USDA, NRCS (U.S. Department of Agriculture, National Resources Conservation Service). 2008. PLANTS profile for common reed. PLANTS Database.

Available:http://plants.usda.gov/java/county?state_name=Utah&statefips=49&symbol=PHAU7. (February 2008).

Windham, Lisamarie, and Joan G. Ehrenfeld. 2003. Net impact of a plant invasion on nitrogen-cycling processes within a brackish tidal marsh. Ecological Applications 13(4):883-896.

Common Reed

Counties the Common Reed is present.
Major Waterways



Richard Old
XID Services, Inc.,
Bugwood.org

Curly-leaf pondweed *Potamogeton crispus*

Ecology: Curly-leaf pondweed is a perennial, rooted, submersed aquatic vascular plant native to Eurasia, Africa and Australia (Stuckey 1979). This species is tolerant of a wide variety of ecological conditions and can occur in both oligotrophic and eutrophic waters (Stuckey 1979). It is found in lakes, ponds, ditches, marshes and canals, and it can tolerate fresh to slightly brackish waters (Capers et al. 2005). This species reproduces predominantly through vegetative buds called "turions," rhizomes and stem fragments (Sastroutomo 1981). Curly-leaf pondweed can remain photosynthetically active during the winter and are often the first plant to appear after ice out. They quickly form dense mats giving this species a competitive advantage over native aquatic plants (Catling and Dobson 1985 as cited by Capers et al. 2005). Unlike most aquatic plants, *P. crispus* dies back in mid summer. This senescence can result in an increase in phosphorus concentrations sometimes causing algae blooms, and a concentration of dead plants along the shore (ISSG 2006). *P. crispus* has the positive effect in some instances of increasing oxygen levels and providing shelter for small fish and aquatic insects, which provide food for larger fish and amphibians (USDA, NRCS 2008).

Distribution: This species was first introduced to northeastern North America in 1860 (Les and Merhoff 1999). It is believed that curly-leaf pondweed was unintentionally introduced and spread through early fish stocking efforts by hatcheries. There is also evidence for deliberate planting (Les and Merhoff 1999). This species has since spread throughout the United States (Sturtevant 2008). Curly-leaf pondweed is now prevalent in the ponds and marshes of northern Utah, where it competes with native pondweeds.

Pathways of Introduction: Curly-leaf pondweed is spread by plant fragments attached to boats and equipment (Johnstone et al. 1985). It is also widely used for horticulture, as an aquarium plant and sold through biological supply houses making it readily available for unintentional or intentional release (Maki and Galatowitsch 2003).

Management considerations***:*** Curly-leaf pondweed spreads from plant fragments, so cleaning all vegetation off boats and equipment before leaving a water body can help prevent spread (ISSG 2006). Control activities for curly-leaf pondweed are most effective in the spring or very early summer before the turions germinate. Options for control include both mechanical and chemical treatment (U.S. Army Corps of Engineers 2004). The U.S. Army Corps of Engineers suggests the use of benthic barriers to control small, high use areas such as boat ramps and docks. Though these methods can be effective, they are too expensive for larger applications. Harvesting can also be used in smaller areas where curly-leaf pondweed is a specific nuisance, however, this may result in further spread of vegetative propagules (U.S. Army Corps of Engineers 2004).

Suggested herbicides include diquat (Reward, Weedtrine-D), endothall (Aquathol, Hydrothol 191), and floridone (Sonar A.S. or Sonar SRP). When choosing a herbicide it is important to note that diquat is not effective in turbid water and Hydrothol is considered toxic to fish. However, diquat and endothall can eliminate plants within 24 hours of exposure and fluridone requires 30 to 60 days to kill plants (U.S. Army Corps of Engineers 2004).

Literature Cited:

Capers, R.S., G.J. Bugbee, R. Selsky, and J.C. White. 2005. A guide to invasive aquatic plants of Connecticut. The Connecticut Agricultural Experiment Station. Bulletin 997, New Haven, Connecticut.

ISSG (Invasive Species Specialist Group). 2006. *Pomatogeton crispus* (aquatic plant). Global Invasive Species Database. Available:http://www.invasivespecies.net/database/species/ecology.asp?si=447&fr=1&sts=sss. (February 2008).

Johnstone, I.M., B.T. Coffey, and C. Howar-Williams. 1985. The role of recreational boat traffic in interlake dispersal of macrophytes: a New Zealand case study. Journal of Environmental Management 20:263-279.

Les, D.H., and L.J. Merhoff. 1999. Introduction of nonindigenous aquatic vascular plants in southern New England: a historical perspective. Biological Invasions 1:281-300.

Maki, K., and S. Galatowitsch. 2003. Movement of invasive aquatic plants into Minnesota (USA) through horticultural trade. Biological Conservation 118(3):389-396.

Sastroutomo, Soetikno S. 1981. Turion formation, dormancy and germination of curly pondweed, *Potamogeton crispus* L. Aquatic Botany 10:161-173.

Stuckey, R. L. 1979. Distributional history of *Pomatogeton crispus* (curly pondweed) in North America. Bartonia 76:22-42.

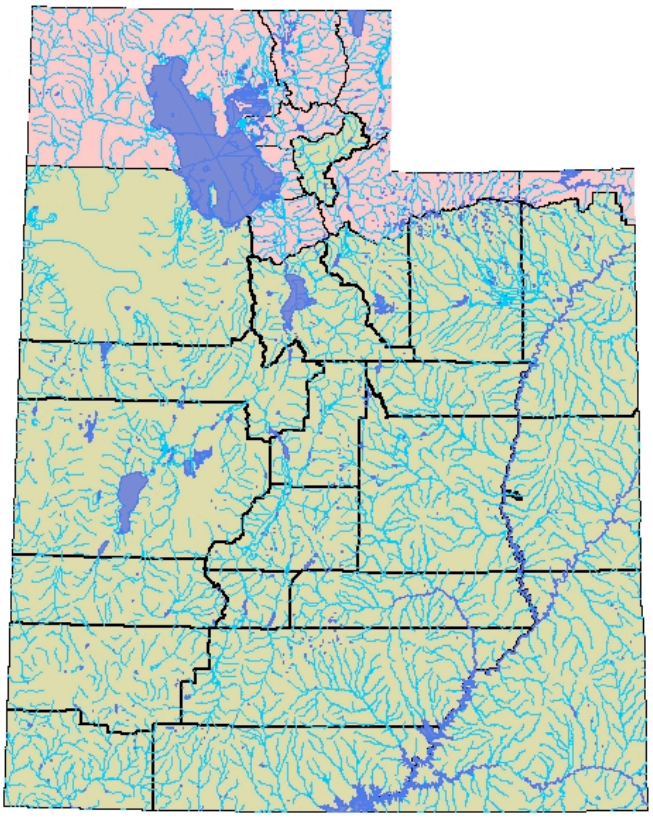
Sturtevant. 2008. *Potamogeton crispus*. USGS (U.S. Geological Survey) Nonindigenous Aquatic Species Database. Available: http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=1134. (February 2008).

U.S. Army Corps of Engineers. 2004. Noxious and Nuisance Plant Management Information System. Available: http://el.erdc.usace.army.mil/pmis/. (February 2008).

USDA, NRCS. 2008. *Potamogeton crispus*. The PLANTS database. Available: http://plants.usda.gov/java/nameSearch?mode=Scientific+Name&keywordquery=Potamogeton+crispus&go.x=5&go.y=10. (February 2008).

Curly-leaf Pondweed

Counties curly-leaf pondweed is present.
Major Waterways



Robert H. Mohlenbrock
USDA-NRCS PLANTS Database

Eurasian watermilfoil *Myriophyllum spicatum*

Ecology: Eurasian watermilfoil is a rooted, submersed macrophyte considered one of the most widespread and problematic aquatic weeds in North America (Ward and Newman 2006). This stoloniferous, perennial, vascular plant consists of long underwater stems that branch and produce whorled, pinnately compound leaves and emergent flowers (Haynes 1988).

Eurasian watermilfoil is extremely adaptable and can survive in a wide range of environmental conditions, though it prefers lakes, ponds, shallow reservoirs and low energy rivers. Eurasian watermilfoil can tolerate freshwater to slightly brackish water and a broad range of temperatures (Spencer and Lekic 1974; Newroth 1985). Watermilfoil will overwinter under the ice utilizing carbohydrate reserves in shoots and roots (Titus et al. 1975). Eurasian watermilfoil requires high light levels and in early spring grows rapidly to the surface where it forms dense canopies that overtop and shade the surrounding vegetation (Titus et al. 1975; Madsen et al. 1991).

Reproduction occurs through sexual and vegetative means and is considered a key characteristic in the successful spread of this species. Fragmentation typically occurs after flowering through autofragmentation or by disturbance from natural causes or human activities (Smith and Barko 1990).

Eurasian watermilfoil affects recreation by interfering with swimming and boating, reducing the quality of sport fisheries and by reducing the aesthetic appeal of the water (Newroth 1985). Eurasian watermilfoil has been shown to have significant negative impacts on the native ecosystems it invades. Watermilfoil negatively affects native plant abundance and density by forming dense mats along the surface of the water resulting in light reduction (Smith and Barko 1990; Madsen 1994). Eurasian watermilfoil supports a lower abundance and diversity of invertebrates and can have long term impacts on fish foraging opportunities, resulting in reduced growth and condition of some fish species (Keast 1984; Lillie and Budd 1992; Engel 1995; Madsen et al. 1995). Eurasian watermilfoil also has less value as a food source for waterfowl than the native plants it replaces (Aiken et al. 1979).

Distribution: Native to Europe, Asia and northern Africa, Eurasian watermilfoil was first documented in North America in 1942 in Washington D.C (Couch and Nelson 1985). Eurasian watermilfoil spread rapidly throughout the United States after its introduction, primarily through human activities (Couch and Nelson 1985). The presence of Eurasian watermilfoil is currently confirmed in 45 states and three Canadian Provinces (Creed 1998; Jacono and Richardson 2008) and it continues to spread. Local populations of Eurasian watermilfoil in Utah were first documented in 1993 and are established in Fish Lake, Otter Creek Reservoir and Mantua Reservoir (Jacono and Richardson 2008; Pers. Comm. Mike Ottenbacher. 2008. Southern Region Aquatic Program Manager, Utah Division of Wildlife Resources; Pers. Comm. Craig Schaugaard. 2008. Northern Region Aquatic Program Manager, Utah Division of Wildlife Resources). It is also found near boat ramps in the waterfowl management areas surrounding the Great Salt Lake and in

Cache county (Pers. Comm. Val Bachman. 2008. Waterfowl Management Area Superintendant, Utah Division of Wildlife Resources).

Long distance spread is linked to the aquarium and aquatic nursery trade, while short distance dispersal is connected with activities that increase watermilfoil fragmentation such as motor boating and mechanical weed harvesting (Reed 1977; Nichols and Shaw 1986).

Pathways of Introduction: It is not known how Eurasian watermilfoil was introduced into Utah waters, but it was likely introduced through boat traffic. While spread can occur by wind, water and waterfowl dispersal, evidence for plant fragment transport is documented as one of the most important dispersal mechanisms for Eurasian watermilfoil (Johnstone et al. 1985; Smith and Barko 1990; Johnson and Carlton 1996).

Management Considerations: Control methods for Eurasian watermilfoil have been widely studied and include mechanical, chemical and biological options (Johnson and Blossey 2002). Mechanical removal is not suggested because of the risk of increasing spread through fragmentation unless infestation has reached peak levels. Harvesting is usually conducted twice during a growing season and cut plants should be removed from the water after harvest. Water draw down is another mechanical control method that has been successful (Bates et al. 1985)

The herbicides 2, 4-D, diquat, diquat and complexed copper, endothall dipotassium salt and endothall, complexed copper and flouridone have been used with success (Westerdahl and Getsinger 1988). There is, however, concern that these methods may harm certain non-target organisms (Nichols 1991; Cooke et al. 1993).

The native North American weevil, *Euhrychiopsis lecontie*, has shown potential for biological control. It has been associated with natural declines of watermilfoil at northern lakes (Sheldon 1994; Bratager et al. 1996). Studies have found the herbivorous weevil to cause significant damage to Eurasian watermilfoil while having little impact on native species (Creed and Sheldon 1994a, 1994b, 1995).

Literature Cited:

Aiken, S.G., P.R. Newroth and I. Wile. 1979. The biology of Canadian weeds. 34. *Myriophyllum spicatum* L. Canadian Journal of Plant Science 59:201-215.

Bates, A.L., E. R. Burns, and D.H. Webb. 1985. Eurasian Watermilfoil (*Myriophyllum spicatum* L.) in the Tennessee-Valley: an update on the biology and control. Pages 104-115 *in* L.W.J. Anderson, editor. Proceedings of the first international symposium on watermilfoil (*Myriophyllum spicatum*) and related Halorgaceae species. Aquatic Plant Management Society, Washington D.C.

Bratager, M., W. Crowell, S. Enger, G. Montz, D. Perleberg, W.J. Rendall, L. Skinner, C.H. Welling and D. Wright. 1996. Harmful exotic species of aquatic plants and wild animals in Minnesota. Minnesota Department of Natural Resources, Annual Report, St. Paul, MN.

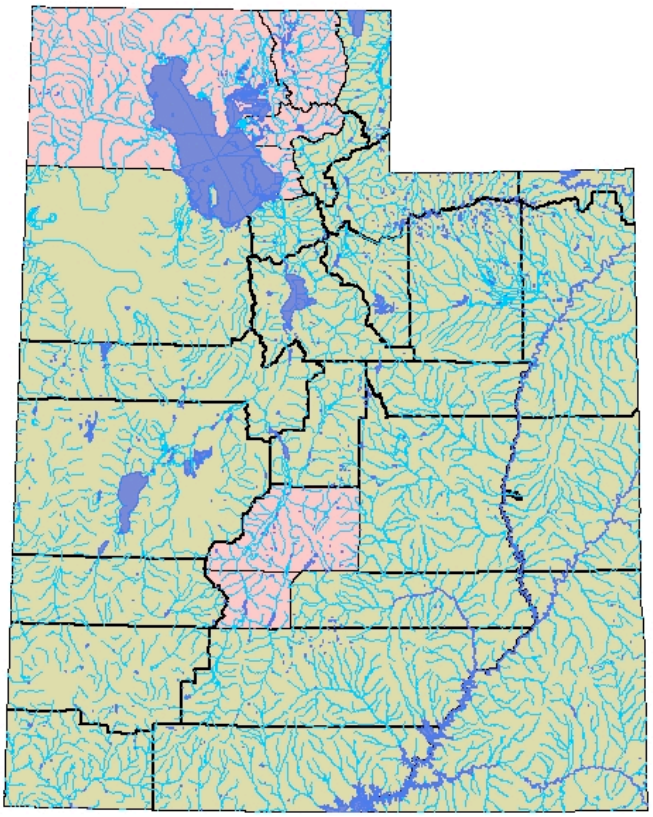
Creed, R. P. 1998. A biogeographic perspective on Eurasian watermilfoil declines:

additional evidence for the role of herbivorous weevils in promoting declines? Journal of Aquatic Plant Management 36: 16-22.
Creed, R. P., and S. P. Sheldon. 1994a. Aquatic weevils (Coleoptera, Curculionidae) associated with northern watermilfoil (*Myriophyllum sibiricum*) in Alberta, Canada. Entomological News 105:98-102.
Creed, R. P., and S. P. Sheldon. 1994b. The effect of two herbivorous insect larvae on Eurasian watermilfoil. Journal of Aquatic Plant Management 32:21-26.
Creed, R. P., and S. P. Sheldon. 1995. Weevils and watermilfoil: did a North American herbivore cause the decline of an exotic plant? Ecological Applications 5:1113-1121.
Cooke, G. D., E. B. Welch, S. A. Peterson, and P. R. Newroth. 1993. Restoration and management of lakes and reservoirs. 2nd edition. Lewis Publishers, Boca Raton, FL.
Couch, R., and E. Nelson. 1985. Myriophyllum spicatum in North America. Pages 8-18 in L.W.J. Anderson, editor. First international symposium watermilfoil and related Haloragaceae species. Aquatic Plant Management Society, Vancouver.
Engel, S. 1995. Eurasian watermilfoil as a fishery management tool. Fisheries 20(3): 20-27.
Haynes, R.R. 1988. Reproductive biology of selected aquatic plants. Annals of the Missouri Botanical Garden 75(3): 805-810.
Jacono, C.C. and M.M. Richerson. 2008. *Myriophyllum spicatum*. USGS (U.S. Geological Service) Nonindigenous Aquatic Species Database. Available: http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=237. (February 2008).
Johnson, R.L. and B. Blossey. 2002. Eurasian watermilfoil. *in* Van Driesche, R., et al., Biological Control of Invasive Plants in the Eastern United States, U. S. Forest Service Publication FHTET-2002-04.
Johnson, L.E., and J.T. Carlton. 1996 Post-establishment spread in large-scale invasions: dispersal mechanisms of the zebra mussel *Dreissena polymorpha*. Ecology 77(6): 1686–1690.
Johnstone, I., Coffey, B. & Howar-Williams, C., 1985. The role of recreational boat traffic in interlake dispersal of macrophytes: a New Zealand case study. Journal of Environmental Management 20:263-279.
Keast, A. 1984. The introduced aquatic macrophyte, *Myriophyllum spicatum*, as habitat for fish and their macroinvertebrate prey. Canadian Journal or Zoology 62:1289-1303.
Lillie, R.A., and J. Budd. 1992. Habitat architecture of *Myriophyllum spicatum* L. as an index to habitat quality for fish and macroinvertebrates. Journal of Freshwater Ecology 7(2): 113-125.
Madsen, J.D. 1994. Invasions and declines of submersed macrophytes in Lake George and other Adirondack lakes. Lake and Reservoir Management 10(1): 19-23.
Madsen, J.D., J.W. Sutherland, J.A. Bloomfield, L.W. Eichler, and C.W. Boylen. 1991. The decline of native vegetation under dense Eurasian watermilfoil canopies. Journal of Aquatic Plant Management 29: 94-99.
Newroth, P.R. 1985. A review of Eurasian watermilfoil impacts and management in British Columbia. Pages 139-153 *in* L.W.J. Anderson, editor. Proceedings of the first international symposium on watermilfoil (*Myriophyllum spicatum*) and

related Halorgaceae species. Aquatic Plant Management Society, Washington D.C.
Nichols, S. A. and B. H. Shaw. 1986. Ecological life histories of three aquatic nuisance plants *Myriophyllum spicatum*, *Potamogeton crispus*, and *Elodea canadensis*. Hydrobiologia 131:3-21.
Nichols, S. A. 1991. The interaction between biology and the management of aquatic macrophytes. Aquatic Botany 41:225-252.
Reed, C. F. 1977. History and distribution of Eurasian watermilfoil in the United States and Canada. Phytologia 36:417-436.
Sheldon SP. 1994. Invasions and declines of submersed macrophytes in New England, with particular reference to Vermont lakes and herbivorous invertebrates in New England. Lake and Reservoir Management 10(1):13-17.
Smith, C.G., and J.W. Barko. 1990. Ecology of Eurasian Watermilfoil. Journal of Aquatic Plant Management 28:55-64.
Spencer, N.R. and M. Lekic. 1974. Prospects for biological control of Eurasian watermilfoil. Weed Science 22:401-404.
Titus, J. and others. 1975. Production Model for *Myriophyllum spicatum* L. Ecology 56(5):1129-1138.
Ward, D. M. and R. M. Newman. 2006. Fish predation on Eurasian watermilfoil (*Myriophyllum spicatum*) herbivores and indirect effects on macrophytes. Canadian Journal of Fisheries and Aquatic Sciences 63(5):1049-57.
Westerdahl, H.E. and K.D. Getsinger, editors. 1988. Aquatic plant identification and herbicide use guide, volume 2: Aquatic plants and susceptibility to herbicides. U.S. Army Corps of Engineers, Technical Report A-88-9, Vicksburg, MS.

Eurasian Watermilfoil

Major Waterways
Counties where Eurasian Milfoil is present.



Alison Fox, University of Florida
www.forestryimages.org

Purple Loosestrife *Lythrum salicaria*

Ecology: Purple loosestrife is an emergent, rhizomatous, perennial with erect stems. The leaves are simple, entire and opposite or whorled with rose-purple flowers consisting of 5 to 7 petals (Whitson et al. 1996). Purple loosestrife prefers aquatic sites along stream banks and shallow ponds, though it has successfully invaded drier regions by utilizing irrigation canals and waterways as pathways to dispersal (Whitson et al. 1996). *L. salicaria* prefers moist soils of neutral to slightly acid pH, however it is found in a wide range of soil textures and types and is able to adjust to seasonal or semi-permanent changes in water levels (Thompson et al. 1999).

The successful spread of purple loosestrife is attributed to its ability to reproduce through seed or vegetative means, prolific seed production and a wide scope of dispersal mechanisms. A mature plant can produce up to 2.7 million seeds and disturbance to underground stems increases spread by encouraging new growth from adventitious shoots and roots (Thompson et al. 1999).

Purple loosestrife has drastically altered wetlands across North America (Thompson et al. 1999). Once *L. salicaria* is established, it outcompetes and replaces native plants (Gaudet and Keddy 1995) that provide higher quality food and habitat for wildlife (Raloff 1992; Brown et al. 2002). *L. salicaria* forms dense homogeneous stands that restrict native wetland plant species and reduce future reproduction by native plants through competition for pollinators (Thompson 1987; Brownet al. 2002). The recreational and overall aesthetic value of wetlands and waterways is diminished as dense stands of *L. salicaria* choke waterways and decrease biodiversity

Distribution*:* Purple loosestrife is of Eurasian origin and has been established in North America since the early 1800's. This species has expanded its distribution from its point of introduction in the northeast to the western United States and north into Canada (Thompson et al. 1999). Purple loosestrife currently inhabits 43 of the 48 contiguous states and is prevalent in Utah's northern wetland areas in Cache, Weber, and Davis counties (Sturtevant 2008). It is also becoming more prevalent in central and eastern Utah and is known to inhabit Salt Lake, Utah, Wasatch, Carbon, Emery, Uintah and Grand counties (Pers. Comm. Ben Franklin. 2008. Botanist, Utah Natural Heritage Program, Utah Division of Wildlife Resources).

Pathways of Introduction: Purple loosestrife spreads downstream through water dispersal of seeds and vegetative matter. Seeds are unintentionally transported and spread with wetland soil carried by animals, humans, boats and vehicles (Thompson et al. 1999). Purple loosestrife is also widely sold as an ornamental in states where regulations do not prohibit its sale and distribution. In Utah, purple loosestrife is listed as a noxious weed and its sale is prohibited.

Management considerations: The best control measure, as with many invasive plants, is to preserve a healthy native ecosystem to prevent or slow invasion (ISSG 2006). Herbicides are the most commonly used method of control for purple loosestrife. Commonly used chemicals include glyphosphate sold as Rodeo® for use in wetlands and

Roundup® for use in uplands, 2, 4-D and Renovate®. However, glyphosphate is nonselective and can kill desirable plants associated with loosestrife if applied carelessly (Butterfield et al. 1996). Multiple chemical treatments are usually required for control as new seedlings emerge annually from the seed bank.

Biological control methods are more effective for long-term control of larger populations of purple loosestrife. In North America four insects have been approved by the U. S. Department of Agriculture for use as biological control agents: the root-mining weevil *Hylobius transversovittatus*, two leaf-feeding beetles *Galerucella calmariensis* and *G. pusilla*, and the herbivorous weevil *Nanophyes marmoratus*. The impact of these introduced beetles on native, non-target species is considered low. *G. calmariensis* has provided successful control of purple loosestrife (Malecki and Blossey 1993).

Literature Cited:

Brown, B.J., R.J. Mitchell and S.A. Graham. 2002. Competition for pollination between an invasive species (purple loosestrife) and a native congener. Ecology 83(8):2328-2336.

Butterfield, C., J. Stubbendieck and J. Stumpf. 1996. Species abstracts of highly disruptive exotic plants. Northern Prairie Wildlife Research Center Online. Available: http://www.npwrc.usgs.gov/resource/plants/exoticab/effilyth.htm. (February 2008).

Gaudet, C.L., and P.A. Keddy. 1995. Competitive performance and species distribution in shortline plant communities: a comparative approach. Ecology 76(1):280-291.

ISSG (Invasive Species Specialty Group). 2006. *Lythrum salicaria* (aquatic plant, herb). Global Invasive Species Database. Available: http://www.invasivespecies.net/database/species/ecology.asp?si=93&fr=1&sts=sss. (February 2008).

Malecki, R.A. and B.Blossey. 1993. Biological control of purple loosestrife. Bioscience 43(10):680-686.

Raloff, J. 1992. From tough ruffe to quagga. Science News 142(4):56-58.

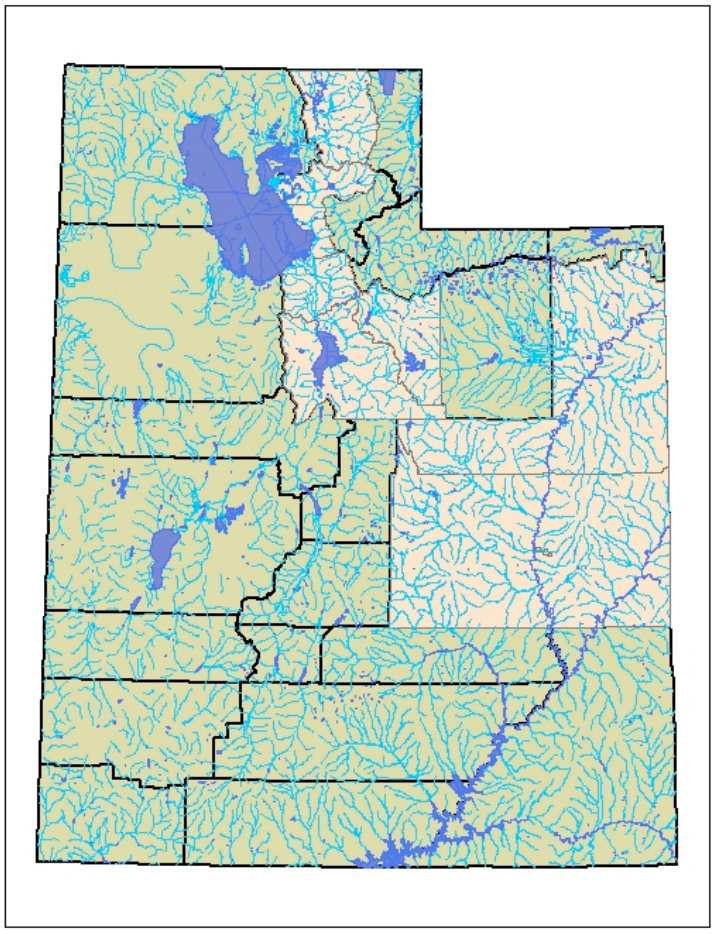
Sturtevant. 2008. *Lythrum salicaria*. USGS (U.S. Geological Society) Nonindigenous Aquatic Species Database. Available: http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=239. (February 2008).

Thompson, D.Q., R.L. Stuckey, and E.B. Thompson. 1999. Spread, impact, and control of purple loosestrife (*Lythrum salicaria*) in North American wetlands. Northern Prairie Wildlife Research Center Online. United States Fish and Wildlife Service. Available: http://www.npwrc.usgs.gov/resource/plants/loosstrf/index.htm. (February 2008).

Whitson, T.D. and others. 1996. Weeds of the West. 5th edition. University of Wyoming, Jackson, WY.

Purple Loosestrife

SGID_U500_Streams
Purple_loosestrife_Present



Paul Champion, NIWA

Tamarisk *Tamarix spp.*

Ecology: Tamarisk is an aggressive invasive species that has caused major ecological disturbance in the southwestern United States. This species has displaced or replaced native plant communities, degraded wildlife habitat, and is cited as a major cause in the decline of many native species, including threatened or endangered species (DeLoach et al. 2000).

Tamarisk is a woody shrub or small tree with alternate, scale-like leaves and smooth reddish-brown bark that becomes furrowed and ridged with age. Flowering occurs in spring and summer and is characterized by the development of clusters of pink flowers, 2 to 5 cm in length. This species reproduces both sexually and vegetatively. The fruit is a long narrow capsule that splits releasing thousands of tiny, hairy seeds in mid summer (MacMahon 1985).

Tamarisk prefers wet, open habitat near streams, reservoirs and irrigation ditches, and it has a wide tolerance of saline and alkaline soils (MacMahon 1985). Tamarisk is particularly successful where natural flooding is attenuated by water regulation such as sections of river downstream of dams (Shafroth et al. 2002; Sher et al. 2002). Tamarisk is able to tolerate drier periods without access to the water table (Smith et al. 1998). It transpires large amounts of groundwater, desiccates soils, and reduces the water table, further giving this species a competitive advantage over native vegetation (Sala et al. 1996; Cleverly et al. 1997; Dahm et al. 2002; Shafroth et al. 2002).

Tamarisk alters channel morphology, competitive hierarchies, and disturbance regimes in riparian ecosystems (Busch and Smith 1995). To its credit, tamarisk's roots stabilize banks and result in enlarged gravel bars and narrowed channels (Cooper et al. 2003). The dense stands formed by this species, coupled with a thick deposition of leaf litter, can be highly flammable, which encourages the spread of wildfires (Busch and Smith 1995). Tamarisk populations increase following a fire, due to their ability to re-sprout more successfully than native plants following a fire event (Hunter et al. 1988; Busch and Smith 1995; Ellis 2001). Altered disturbance regimes and hydrology, has allowed tamarisk to replace many native tree species including cottonwood *Populus deltoides* and willows *Salix spp.* (Cooper et al. 2009). This change in plant communities has altered native food webs and further changed the ecology of the ecosystem (Kennedy and Hobbie 2004).

Distribution: Originally native to Asia and southeastern Europe, tamarisk was introduced in the early 1800's to North America (Sobhian et al. 1998). It has since been extensively naturalized in the southwestern United States (MacMahon 1985) and it is now found in 42 of the 48 continental states (USDA, NRCS 2008). In Utah, tamarisk has spread extensively along the Green, Colorado and Yampa rivers and their tributaries. This species is now found in nearly every county in Utah (USDA, NRCS 2008).

Pathways of Introduction: Tamarisk was intentionally introduced as an ornamental, to serve as windbreaks and for stabilizing banks for erosion control (Sobhian et al. 1998). It

has since increased its range by spread through its abundant wind-borne seeds and vegetatively with the breakage and downstream dispersal of cuttings.

Management Considerations: A variety of methods have been used to control or eradicate tamarisk, including mechanical, chemical and biological treatments. Because this species is very difficult to eradicate once established, early intervention is important. Mechanical treatments include hand pulling young plants and bulldozing followed by root-plowing (Carpenter 2003).

Tamarisk can be controlled chemically using foliar sprays, cut-stump, or injection and frill treatments (USACE 2004). Chemical treatment through the application of herbicides, such as imazpyr and glyphosphate, has been used in dense monocultures of tamarisk with success (Carpenter 2003). Another technique for large stands is the use of burning followed by herbicide application to the re-sprouts. A widely used control technique for smaller applications or in mixed stands, where selectivity is desired, is called the cut stump method. This involves cutting the mature trees and applying triclopyr (Garlon4® or Remedy®) mixed with oil to the stumps or basal bark applications on plants (Carpenter 2003).

Biological control techniques using cattle and goats are unsuccessful if used alone. However, when goats are used as a post burning method to control re-growth they have been successful (Carpenter 2003). A biocontrol agent, the saltcedar leaf beetle *Diorhabda elongata* has been released in nine western states including Utah. Control by the leaf beetle is gradual and is expected to take up to three years. The mealybug *Trabutina mannipara* and the weevil *Coniatus tamarisci* have also been approved but not yet released, while awaiting results from beetle introductions (DeLoach et al. 2004)

Literature Cited:

Busch, D. and S. Smith. 1995. Mechanisms associated with decline of woody species in riparian ecosystems of the southwestern U.S. Ecological Monographs 65(3): 347-370.

Carpenter, A. 2003. Element Stewardship Abstract for *Tamaix ramosissima* Ledebour. The Nature Conservancy Wildland Weed Management and Research Program. Available: http://tncweeds.ucdavis.edu/esadocs/documnts/tamaram.pdf. (April 2008).

Cleverly, J. et al. 1997. Invasive capacity of *Tamarix ramosissima* in a Mojave Desert floodplain: the role of drought. Oecologia 111(1): 12-18.

Cooper, D.J., D.C. Andersen and R.A. Chimner. 2003. Multiple pathways for woody plant establishment on floodplains at local to regional scales. The Journal of Ecology 91(2): 182-196.

Dahm, C. et al. 2002. Evapotranspiration at the land/water interface in a semi-arid drainage basin. Freshwater Biology 47(4): 831-843.

DeLoach, J. et al. 2000. Ecological interactions in the biological control of saltcedar (*Tamarix spp*.) in the United States: toward a new understanding. Pages 819-873 *in* Proceedings of the X International Symposium on Biological Control Weeds. Montana State University.

Ellis, L.M. 2001. Short-term response of woody plants to fire in a Rio Grande riparian forest, Central New Mexico, USA. Biological Conservation 97(2): 159-170.

Hunter, W., R. Ohmart and B. Anderson. 1988. Use of exotic saltcedar (*Tamarix chinensis*) by birds in arid riparian systems. The Condor 90:113-123.

Kennedy, T. and S. Hobbie. 2004. Saltcedar (*Tamarix ramosissima*) invasion alters organic matter dynamics in a desert stream. Freshwater Biology 49:65-76.

MacMahon, J. 1985. Deserts. Alfred A. Knopf, Inc., New York.

Sala, A., S. Smith and S. Devitt. 1996. Water use by *Tamarix ramosissima* and associated phreatophytes in a Mojave desert floodplain. Ecological Applications 6(3): 888-898.

Shafroth, P.B., J.C. Stromberg and D.T. Patten. 2002. Riparian vegetation response to altered disturbance and stress regimes. Ecological Applications 12(1): 107-123.

Sher, A.A., D.L. Marshall and J.P. Taylor. 2002. Establishment patterns of native *Populus* and *Salix* in the presence of invasive nonnative *Tamarix*. Ecological Applications 12(3): 760-772.

Smith, S. et al. 1998. Water relations of riparian plants from warm desert regions. Wetlands 18:687-696.

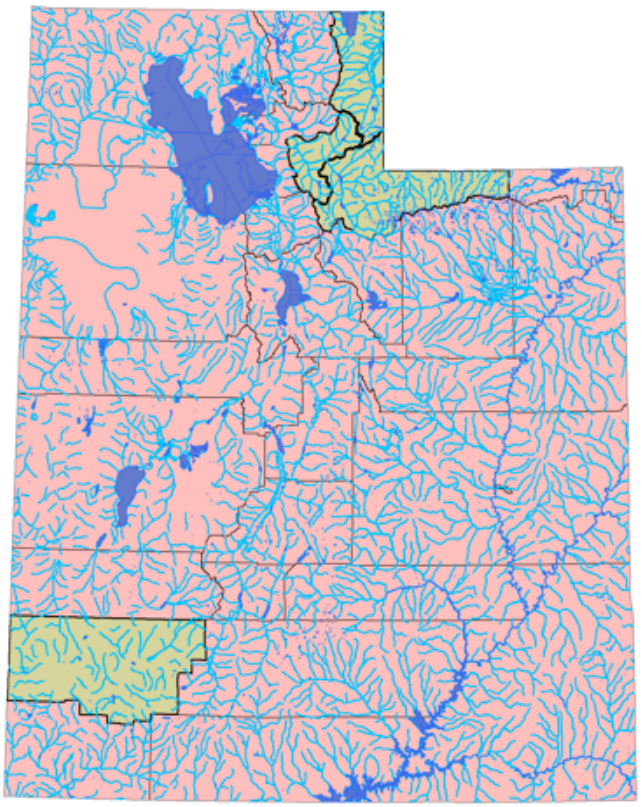
Sobhian, R. et al. 1998. Field evaluation of natural enemies of *Tamarix spp*. in southern France. Biological Control 12(3): 164-170.

USACE (U.S. Army Corps of Engineers). 2004. Herbicides used for *Tamarix spp*. (tamarisk or salt cedar) management. Noxious and Nuisance Plant Management Information System. Available: http://el.erdc.usace.army.mil/pmis/. (April 2008).

USDA, NRCS (U.S. Department of Agriculture, National Research Conservation Society). 2008. PLANTS profile for *Tamarix* (tamarisk). Available: http://plants.usda.gov/java/profile?symbol=TAMAR2. (April 2008).

Tamarisk

Major Waterways
Counties Tamarisk is present in.



Forest & Kim Starr,
U.S. Geological Survey,
Bugwood.org

Steve Dewey,
Utah State University,
Bugwood.org

MOLLUSKS

Asian Clam *Corbicula fluminea*

Ecology: Asian clams are bi-valve filter feeders that remove particles (plankton) from the water column. The Asian clam is distinguished by an outer shell of yellow-brown with concentric rings which flake, leaving white spots. The inside of their shells are pearl to purple in color.

Their ability to reproduce rapidly, coupled with a low tolerance for cold temperatures, produces wild swings in population sizes, from year to year, in northern water bodies. *C. fluminea* is found at or slightly below the sediment surface, in both lotic and lentic habitats, over its native range in southeastern Asia. In the United States, *C. fluminea* has been most successful in well-oxygenated clear waters (Belanger et al. 1985; Stites et al., 1995). Fine clean sand, clay, and coarse sand are favored substrates, although they may be found in lower numbers on most substrate types (Belanger et al. 1985). Maximum Asian clam density has been reported to vary between 1,000/m^2 (Stites et al. 1995) and 2,320/m^2 (Sinclair 1971a; Sinclair 1971b). *C. fluminea* is more common and occurs at higher densities in stream pools than in stream runs (Blalock and Herod 1999).

In their native habitat, Asian clams occur mostly in freshwaters, however, they have been reported from brackish and estuarine habitats, but are typically not as abundant in such habitats as in freshwaters (Carlton 1992). Asian clams can tolerate salinities of up to 13 ppt for short periods of time. If allowed to acclimate, they may tolerate salinities as high as 24 ppt (King et al. 1986), though; lower salinities are preferred (Morton and Tong 1985).

This species also appears to tolerate low temperatures well. Viable populations have been reported surviving temperatures of 0-2°C in the Clinton River, Michigan (Janech and Hunter 1995). However, low temperatures do limit reproduction, since veligers are typically released at temperatures of 16°C or higher (Hall 1984).

Life span varies with habitat, with a maximum reported life span of approximately 7 years (Hall 1984). *C. fluminea* can self-fertilize releasing up to 2,000 juveniles per day and more than 100,000 juveniles in a lifetime. Juveniles are only 1mm long when discharged and take one to four years to reach maturity. Adults can reach lengths up to 5 cm (Hall 1984).

Distribution:

The first collection of *C. fluminea* in the United States was recorded in 1938, along the banks of the Columbia River, near Knappton, Washington. (Counts 1986). Currently, it is found in 38 states and the District of Columbia. (Foster 2008).

In Utah (Figure 1), there has been a known population of *C. fluminea* in Lake Powell since the mid 1970's. This population, however, was likely established in the Colorado River prior to completion of the Glen Canyon Dam, in 1960 (Pers. Comm. 2008. Larry Dalton, Aquatic Invasive Species Coordinator, Utah Division of Wildlife Resources).

Recently, they have been found at various locations along the Jordan River, which flows from Utah Lake, into the Great Salt Lake (Pers. Comm. 2008. Larry Dalton, Aquatic Invasive Species Coordinator, Utah Division of Wildlife Resources). The Jordan River provides water to a significant canal system, so the clams are probably throughout Utah Valley and the Salt Lake Valley. Utah Lake is an essential element of the Central Utah Project, receiving water as a trans-basin diversion from the Green and Colorado River drainages via Strawberry Reservoir. The reservoir receives water from 10 south slope Uinta Mountain drainages via an extensive underground collection system. Those drainages would have eventually entered the Green River and the Colorado River, which drain into Lake Powell. The fouling effects of Asian clams will likely create problems within this system (Pers. Comm. 2008. Eric Larson, Central Utah Project Coordinator, Utah Division of Wildlife Resources). *C. fluminea* was confirmed in northern Utah's Willard Bay (both its inflow and outflow) in the Spring of 2007 (Pers. Comm. 2008. Larry Dalton, Aquatic Invasive Species Coordinator, Utah Division of Wildlife Resources); it receives water from the Weber River. *C. fluminea* is also found in Yuba Reservoir in south central Utah (Pers. Comm. 2008. Don Willey, Central Region Aquatic Program Manager, Utah Division of Wildlife Resources).

Pathways of Introduction: *C. fluminea* was thought to have first entered the United States as a food item (Foster 2008). *C. fluminea* is thought to spread primarily by humans through activities such as bait bucket introductions (Counts 1986), accidental introductions associated with imported aquaculture species (Counts 1886), and intentional introductions by people who buy or sell them as a food item in markets (Devick 1991). The only other noteworthy dispersal agents are water currents or flooding events (Isom 1886).

Management Considerations: Although the Asian clam grows and disperses less rapidly than the *Dreissena* mussels, it too is causing considerable fouling problems and is threatening native species. Costs associated with its fouling damage are about $1 billion/yr (Office of Technology Assessment 1993). *C. fluminea* populations are controlled by a variety of methods. Where intakes pipes are fouled, thermal regulation is employed, whereby water in the pipes is heated to temperatures exceeding 37°Celsius. However, this method is not practical in most water systems (Balcom 1994). Mechanical methods, such as using screens and traps, can effectively dispose of older clams and remove body tissue and shells from the system (Balcom 1994). Chemicals, such as small concentrations of chlorine or bromine, are used to kill juveniles and sometimes adults. (This method is very effective, but because of increasing restrictions on the amounts of these chemicals that may be released from a facility, managers have been moving away from this method (Balcom 1994).

Literature Cited:

Balcom, N.C. 1994. Aquatic Immigrants of the Northwest. Connecticut Sea Grant College Program. Available: http://www.sgnis.org/publicat/nespp_4.htm (September 2008).

Blalock H. N., H. J. Herod. 1999. A comparative study of stream habitat and substrate utilized by Corbicula Fluminea in the new river. Florida Scientist 62(2):145-151.

Belanger, S.E., J.L. Farris, D.S. Cherry, and J. Cairns, Jr. 1985. Sediment preference of the freshwater Asiatic clam, *Corbicula fluminea*. The Nautilus 99(2-3):66-73.

Carlton, J. T. 1992. Introduced marine and estuarine mollusks of North America: an end-of-20th-century perspective. Journal of Shellfish Research 11:489-505.

Counts, C. L., III. 1986. The zoogeography and history of the invasion of the United States by *Corbicula fluminea* (Bivalvia: Corbiculidae). American Malacological Bulletin, Special Edition No. 2:7-39.

Devick, W. S. 1991. Patterns of introductions of aquatic organisms to Hawaiian freshwater habitats. New Directions in Research, Management and Conservation of Hawaiian Freshwater Stream Ecosystem. Proceedings Freshwater Stream Biology and Fisheries Management Symposium 180-213.

Foster, A. M., P. Fuller, A. Benson, S. Constant, D. Raikow. 2008. *Corbicula fluminea*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. Available: http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=92 (September 2008).

Hall, J.J. 1984. Production of immature Corbicula fluminea (Bivalvia: Corbiculidae), in Lake Norman, North Carolina. The Nautilus 98(4):153-159.

Isom, B.G. 1986. Historical review of Asiatic clam (Corbicula) invasion and biofouling of waters and industries in the Americas. American Malacological Bulletin, Special Edition No. 2:1-5.

Janech M. G., R. D. Hunter. 1995. *Corbicula fluminea* in a Michigan river: implications for low temperature tolerance. Malacological Review 28:119-124.

King, C.A., C.J. Langdon, and C.L. Counts, III. 1986. Spawning and early development of *Corbicula fluminea* (Bivalvia: Corbicularidae) in laboratory culture. American Malacological Bulletin 4(1):81-88.

Morton, B., and K.Y. Tong. 1985. The salinity tolerance of *Corbicula fluminea* (Bivalvia: Corbiculoidea) from Hong Kong. Malacological Review 18:91-95.

Stites, D.L., A.C. Benke, and D.M. Gillespie. 1995. Population dynamics, growth, and production of the Asiatic clam, *Corbicula fluminea*, in a Blackwater River. Canadian Journal of Fisheries and Aquatic Sciences 52:425-437.

Office of Technology Assessment. 1993. Harmful Non-Indigenous Species in the United States. Washington, DC: Office of Technology Assessment, United States Congress.

Sinclair, R. M. 1971a. Corbicula variation and *Dreissena* parallels. Biologist 53(3): 153-159.

Sinclair, R. M. 1971b. Annotated bibliography on the exotic bivalve *Corbicula* in North America, 1900-1971. Sterkiana 43:11-18.

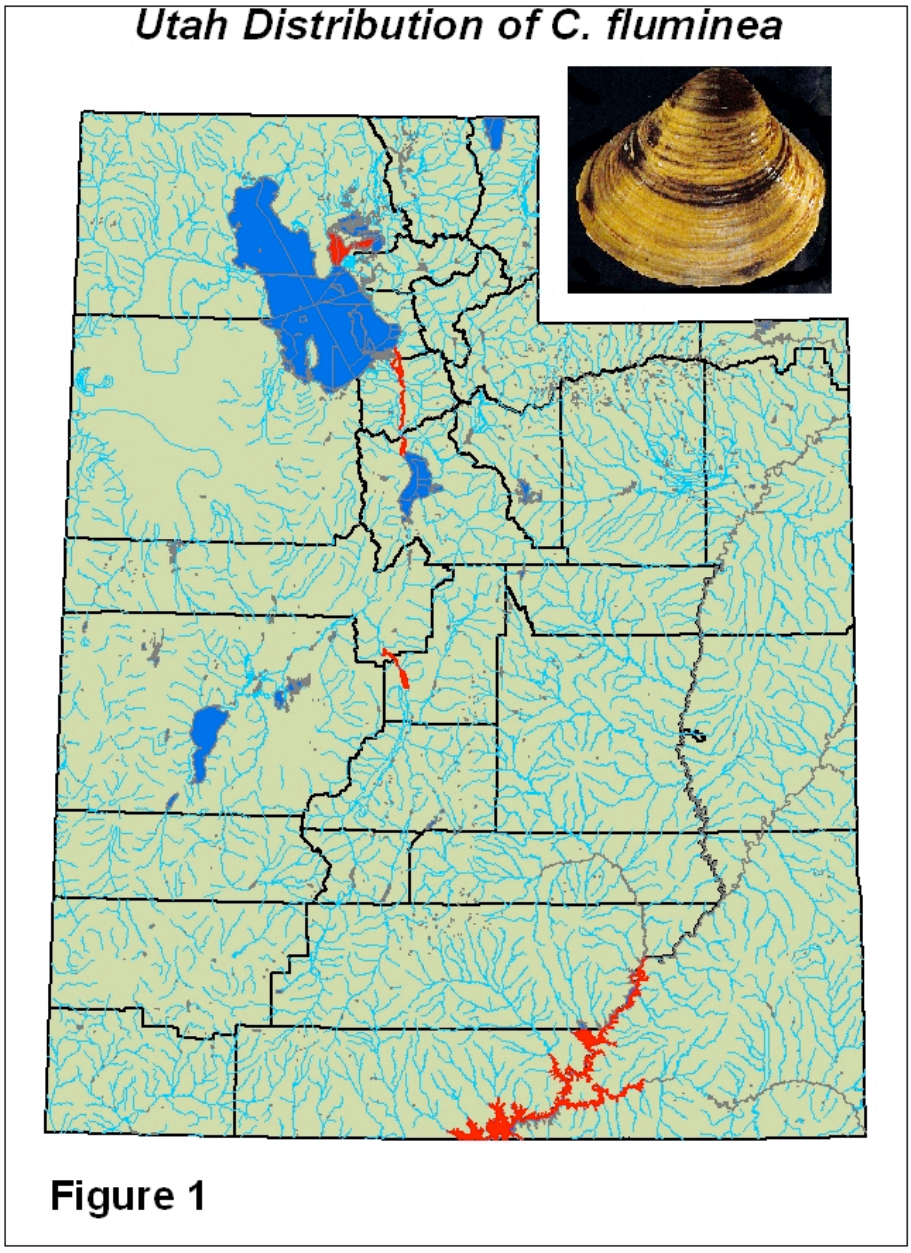


Figure 1

Dreissenid Mussels:
Quagga Mussel *Dreissena bugensis*
Zebra Mussel *Dreissena. Polymorpha*
False Darkmussel *Mytilopsis leucophaeata*

Ecology: Quagga (*D. bugensis),* zebra (*D. polymorpha*) and the dark falsemussel (*M. leucophaeata*) are all invasive mussels that threaten Utah's waters. Closely related cousins, these species have similar characteristics that will collectively be referred to as *Dreissenid* mussels. *Dreissenid* mussels are small, freshwater, bivalve mollusks with elongated shells, typically marked by alternating light and dark bands (zebra stripes). Shell patterns in zebra mussels, however, can vary to the point of having only light or dark colored shells and no stripes. Color patterns in quagga mussels vary more, with black, cream, or white bands. They usually have dark concentric rings on the shell on their ventral side and are paler in color near the hinge. In general, *M. leucophaeata* resembles *D. polymorpha*, with young individuals being especially difficult to distinguish. Adult individuals are usually brownish in color without the stripe patterns that are typical to young individuals (Marelli and Gray 1983).

Zebra mussels range in size from 1-5 mm in their juvenile form to greater than 15 mm in the adult form. The quagga can grow slightly larger than the zebra mussel; up to 20-22 mm in size. *M. leucophaeata* is the largest of the three *Dreissenid* mussels and may reach a maximum size of 22 to 25 mm in length (Siddall 1980, Pathy and Mackie 1993). Another distinguishing characteristic that can aid in species identification is shell shape. The quagga has a convex ventral side and when placed on its side the quagga mussel will topple over, whereas the zebra mussel will not (Claudi and Mackie 1994). The shell shape of *M. leucophaeata* is less angular than in *D. polymorpha* and does not have the longitudinal ridge typical to *D. polymorpha*. The exact species identification of *M. leucophaeata*, however, is based on an internal shell structure, requiring microscopic examination of the structure for species identification (Marelli and Gray 1983).

Dreissenids have considerable genetic and morphological plasticity as well as broad environmental tolerances that enable them to live in a wide variety of habitats. *Dreissenid* mussels also have byssal threads that allow easy attachment to most surfaces including other living organisms (e.g. other mussels, crayfish and turtles). *Dreissenid* mussels even attach to each other, forming dense layered colonies up to one foot thick. Mussel densities of over 1 million individuals per square meter have been recorded in parts of Lake Erie. Though *Dreissenid* mussels can attach to living organisms, they typically adhere to hard surfaces such as: rocks, concrete, steel, pilings, metal grates, boat motors, boat hulls, docks, anchor lines, buoy lines etc. Extensive siltation, microalgae, fluctuating water levels, and antifouling coated surfaces limit colonization.

Dreissenid mussels are diverse, but also have some defined environmental limitations. Zebra mussels can live at water temperatures approaching freezing, but spawning stops below 10ºC, and growth slows as temperatures decline. Cold temperatures can also reduce density. Zebra mussels die when the water temperature falls to levels that would cause ice to form within their bodies. On the opposite end of the temperature spectrum,

lethal high temperatures are reached at between 31ºC and 35ºC. Quagga mussels have a greater tolerance for cooler water temperatures than zebra mussels; thus, they have been found to colonize substrates at greater water depths. Observations and research suggest that the North American quagga mussel is a cold, deep-water form, contrasting with Ukraine populations where the quagga mussel thrives at higher temperatures. In North America, zebra mussels survive indefinitely at 30°C, but the quagga mussel exhibits high mortality at this same temperature (Mills et al. 1996). Although there are indications that quagga die at lower temperatures than zebra mussels, there are a few exceptional quagga populations that are as tolerant of elevated temperatures as zebra mussels, so the potential thermal range of this species may be higher than recent experiments indicate (Mills et al. 1996).

Temperature is also a key factor in spawning and fertilization of *Dreissenid* mussels. A minimum spawning temperature of 12°C has been reported for zebra mussels compared to a 9°C spawning temperature for quagga mussels, which suggests the zebra mussel cannot successfully colonize hypolimnial waters. Although, zebra mussels have been reported to survive in the hypolimnion, they cannot reproduce there (Claxton and Mackie 1998). In contrast, a female quagga mussel with mature gonads was found in Lake Erie at a temperature of 4.8°C, so areas that were thought to be immune to quagga mussel colonization may be at risk (Claxton and Mackie 1998).

M. leucophaeata is considered a warm water species that is able to live in temperate areas also. The majority of individuals, however, do not survive harsh winter conditions (Marelli and Gray 1983). Temperature also affects reproduction. According to Verween et al. (2005) the gamete maturation starts at about 13°C, which is slightly higher than that for *D. polymorpha*. The lower temperature limit for the survival of juvenile and adult *M. leucophaeata* is not known. This factor might limit the establishment of permanent populations in a highly seasonal environment where winter temperatures fall close to 0°C, as in the northern Baltic Sea.

Because zebra mussels need a good deal of calcium to form their shells, they need water containing calcium levels of 25 parts per million or greater. Potential for spawning is very low below 9 parts per million of calcium. Zebra mussels thrive in waters with pH levels between 7.5 and 8.7. The threshold for survival of adults is 6.5 (McCauley and Kott 1993) and for larvae, 6.9 (Mackie and Kilgour 1993). Zebra mussels also require relatively high oxygen concentrations. Little, if any, colonization will occur at dissolved oxygen concentrations less than 40 to 50 percent air saturation (McMahon and Ussery 1995). The optimal water velocity for colonization is between 0.09 to 1.0 meters per second. Colonization potential does not decrease until velocities either exceed 1.5 meters per second or drop below 0.075 meters per second (O'Neill 1996).

Salinity is also a limiting factor in the growth and survival of *Dreissenid* mussels. Zebra and quagga mussels, generally considered fresh water species (<0.5 parts per thousand or <0.05% total salinity), can inhabit brackish areas ranging from 0.2 parts per thousand (0.02%) to as high as 12.0 parts per thousand (1.2%) total salinity (MacNeill 1990). Where as the false darkmussel is a highly euryhaline species, occurring from fresh water

to saline water exceeding 20 parts per thousand (2%) total salinity. According to Siddall (1980), *M. leucophaeata* is able to complete larval development in salinities up to 32 parts per thousand (3.2%) total salinity. The species occurrence in Europe is concentrated to estuarine areas with fluctuating salinity conditions. In Belgium, *M. leucophaeata* has established vigorous fouling communities in conditions where salinity varies from 0.8 parts per thousand (0.08%) to 10.3 parts per thousand (1.03%) total salinity during the reproductive period (Verween et al. 2005). Due to the wide salinity tolerance *M. leucophaeata* has been reported to coexist with *D. polymorpha* in Europe (Jenner and Janssen-Mommen 1993.) In North America the distribution of *M. leucophaeata* and *D. polymorpha* overlap especially when salinities are below 3.0 parts per thousand (0.3%) total salinity (Pathy and Mackie 1993).

In Utah, the brackish water areas associated with the major inlet bays and minor inlet drainages along the east and south sides of the Great Salt Lake support massive wetlands utilized by millions of waterfowl and other waterbirds. Salinity profiles are suggestive that *Dreissenid* mussels could inhabit those brackish wetland areas. For example, Farmington Bay evidences <0.5 parts per thousand (<0.05%) to 60 parts per thousand (6%) total salinity, while Bear River Bay evidences <0.5 parts per thousand (<0.05%) total salinity. And, typical salinity in the tributary flows through the brackish water wetlands prior to entering the Great Salt Lake average 13 parts per thousand (1.3%) to 30 parts per thousand (3%) total salinity depending on season of year. The main north and south arms of the lake would not be suitable habitat, since total salinity ranges from 260 parts per thousand (26%) to 280 parts per thousand (28%) in the North Arm and 70 parts per thousand (7%) to 150 parts per thousand (15%) in the South Arm (Pers. Comm. Clay Perschon. 2008. Aquatic Research Coordinator, Utah Division of Wildlife Resources). The potential invasion of *Dreissenid* mussels, including competition for plankton and algae resources, and the disposition for *Dreissenids* to stimulate botulism outbreaks could compromise the migratory waterbird populations associated with the Great Salt Lake ecosystem (Pers. Comm. 2008. Larry Dalton, Utah Division of Wildlife Resources, Aquatic Invasive Species Coordinator).

Dreissenid mussels produce microscopic larvae (veligers) that float freely in the water column at numerous depths. Females generally reproduce in their second year by expelling eggs in the spring and summer, which are fertilized outside of the body by males, depending on the water temperature. Spawning begins as ambient water temperatures reach approximately 12°C and peaks as temperatures reach the 15°C to 17°C range (Claudi and Mackie 1994). Spawning may be interrupted when temperatures exceed 28°C and will resume when temperatures cool below that threshold (Nichols and Black 1994). Spawning has occurred in the Great Lakes at temperatures as low as 10°C and larvae have been seen throughout the winter months. Yearlong spawning by quagga mussels seems to be evident in Lake Mead situated in the lower Colorado River drainage (Pers. Comm. 2008. Brian Moore, National Park Service, Lake Mead National Recreation Area, Aquatic Resource Coordinator). In contrast, *M. leucophaeata*, in Europe, typically have only one yearly spawning period of approximately four months (Verween et al. 2005). Dreissenid mussel spawning produces planktonic veligers approximately 40 microns in length that are capable of active swimming for one to two weeks. Within two

to five weeks of hatching, the larval mussels become too large (200+ microns) and heavy to remain planktonic, and they begin to settle out of the water column (Nichols and Black 1994). At this point, the veligers must find a hard substrate upon which to attach themselves. Once attached, the lifespan of a *Dreissenid* mussel ranges from 3 to 9 years.

Dreissenid mussels have severe negative impacts on aquatic ecosystems, wreaking havoc on native organisms and native fish populations. *Dreissenid* mussels are filter feeders consuming phytoplankton and zooplankton from the water column. *Dreissenid* mussels are efficient and can filter up to 1 liter of water per day per individual. They have the capability of filtering an entire lake's volume in a matter of days. This leads to an increase in water clarity and greater penetration of sunlight, allowing development of unwanted macrophytes. Plankton is microscopic, and if substantially removed by *Dreissenid* mussels, allows the smallest and most basic part of the food chain to be broken, which can have devastating effects on life cycles of plants, animals, and fish. *Dreissenid* mussels can also pollute the water by encapsulating undesirable plankton, releasing a resultant pseudofeces back into the water to rot. Impacts associated with the filtration of water include increases in water transparency, decreases in mean chlorophyll, and concentration and accumulation of pseudofeces (Claxton et al. 1998). Increased amounts of pseudofeces in the water have been associated with poor water quality, foul odor and taste. As the waste particles decompose, oxygen is used up, the pH becomes very acidic, and toxic byproducts are produced. In addition, *Dreissenid* mussels accumulate organic pollutants within their tissues to levels more than 300,000 times greater than concentrations in the environment, impacting predators who consume the mussel. Also, the pollutants are bound in the pseudofeces, which can be passed up the food chain; therefore, increasing wildlife exposure to organic pollutants (Snyder et al. 1997).

Distribution:

Zebra mussels

Zebra mussels are native to the Black, Caspian and Azov seas. They were first introduced into North America by transoceanic ships, entering the Great Lakes system around the mid 1980's, ultimately being discovered in the United Stated during 1988 in Lake St. Clair. Since introduction they have spread throughout the Great Lakes region, along its major tributary and effluent rivers (O'Neill 1996). In 2007 it was evident that they had crossed the 100th meridian, invading Pueblo Reservoir in south-central Colorado (Pers. Comm. 2008. Elizabeth Brown, Aquatic Invasive Species Coordinator, Colorado Division of Wildlife) and San Justo Reservoir in west-central California (Pers. Comm. 2008. Susan Ellis, Aquatic Invasive Species Coordinator, California Fish and Game). *Dreissenid* mussels have been interdicted alive on trailered boats in California, Washington, and British Columbia (Pers. Comm. 2008. Susan Ellis, Aquatic Invasive Species Coordinator, California Department of Fish and Game; Pers. Comm. 2008. Allen Pleus, Aquatic Invasive Species Coordinator, Washington Department of Fish and Wildlife; Pers. Comm. 2008. Leif-Matthias Herborg, Provincial Aquatic Invasive Species Coordinator, British Columbia) as well as at many other areas of the nation. Those apprehensions resulted in decontaminations to kill the mussels.

Quagga mussels
Quagga mussels are indigenous to the Dneiper River drainage of Ukraine and are now abundant in the Great Lakes region. This species was first documented in the Great Lakes in September 1989, and after confirmation that the mussel was not a variety of zebra mussel, the new species was named "quagga mussel" after the quagga, an extinct African relative of the zebra (O'Neill 1996). More recently quagga mussels have established themselves west of the 100th meridian, probably being transported on a trailered, recreational boat. In 2007, quagga mussels were confirmed in Lake Mead, Lake Mojave and Lake Havasu along the lower Colorado River (Pers. Comm. 2008. Brian Moore, National Park Service, Lake Mead National Recreation Area, Aquatic Resource Coordinator). Downward drift of planktonic veligers in the Colorado River and via its diversions has resulted in widespread contamination of the entire lower Colorado River Basin. These contaminations include waters served by the Southern California Aqueduct in California (Pers. Comm. 2008. Susan Ellis, Aquatic Invasive Species Coordinator, California Department of Fish and Game) and the Central Arizona Project, including the Salt River Project in Arizona (Pers. Comm. 2008. Tom McMahon, Aquatic Invasive Species Coordinator, Arizona Game and Fish Department).

Dark falsemussels
The dark falsemussel is a brackish water species with an original distribution in the subtropical and temperate Gulf of Mexico area (Marelli and Gray 1983). The current distribution along the North Atlantic west coast extends north to Massachusetts in the United States (Smith and Boss 1996). The first record of this species in Europe was made in Belgium during 1835 (Verween et al. 2005), where it was probably transported by the shipping industry. In northwestern Europe, *M. leucophaeta* currently occurs in estuaries along the North Sea coast from Germany to France and into Great Britain (Oliver et al. 1998 and Verween et al. 2005).

Pathways of Introduction: The rapid invasion of North America and recent expansion of *Dreissenids* into the west has been exponential due to their ability to disperse at all different stages of life. *Dreissenid* mussels disperse in many different ways. The first way they move is naturally, being carried passively as planktonic larvae (veligers) in flowing or wind-driven (wave) water currents and by attaching themselves to other organisms such as crayfish or turtles. They may also attach to legs, feet, and feathers of waterfowl and shore birds, but transport on animals is only a low-level vector (Carlton and Johnson 1993). *Dreissenid* mussels are most typically transported by humans within vehicles or vessels capable of storing and moving water. Recreational boating and the ability to move boats and other equipment long distances in short periods of time is the primary vector and has increased the potential spread of these mussels. All life forms of *Dreissenid* mussels can be transported in many ways including the following: ballast systems, live wells, bait wells, bilge tanks, ski storage areas, cooling systems, and basically anywhere water can be stored on a boat. Adult *Dreissenid* mussels are more likely to attach themselves to boats and equipment and can survive several days out of the water. Some adults have been known to survive up to 27 days in the right conditions of cool temperatures and high humidity. Their veligers are more susceptible to dying in hot, dry

conditions (McMahon and Ussery 1995). All human forms of introduction can be prevented if the proper precautions and decontamination procedures are followed.

Management consideration: Monitoring and control of *Dreissenid* mussels costs millions of dollars annually, and could cost water users in Utah upwards of 15 million dollars a year in additional maintenance costs for water delivery and use systems (Pers. Comm. 2008. Mike Suflita, Senior Engineer, Utah Division of Water Resources). *Dreissenid* mussels have the biofouling capabilities of colonizing water supply pipes, inhabiting hydroelectric power plants, disrupting public water supply plants, and in all cases reducing water flow drastically, which increases the maintenance costs at industrial facilities (O'Neill 1996). *Dreissenid* mussels are a threat to more than just the world of recreational water use of boating and fishing. They are a threat to (1) every person who turns on the tap to get a glass of water; (2) every person or industry that utilizes water; and (3) every farmer who uses irrigation pipes or canals to move water to their crops (Pers. Comm. Larry Dalton. 2008. Aquatic Invasive Species Coordinator, Utah Division of Wildlife Resources).

Many different approaches to management of *Dreissenid* mussels have been considered and executed, most resulting in only limited success. To date, no single "silver bullet" *Dreissinid* mussel control technology has been identified. None will work in all water settings, and many control measures pose significant risks to the environment. However, a wide variety of control methods do exist for *Dreissenid* mussels, and many are suitable or practical for some situations. The following information, gleaned from the U.S. Bureau of Reclamation's draft (2008) "Upper Colorado Region Prevention and Rapid Response Plan for *Dreissenid* Mussels," utilized the database on the U.S. Army Corps of Engineers' website *www.el.erdc.usace.army.mil/zebra/zmis/idxlist.htm*.

Non-chemical Control (U.S. Bureau of Reclamation 2008)
Table 2 (Author's Note: No Table 1 is presented) presents information on an array of non-chemical methods for controlling *Dreissenid* mussels. Also, if equipment or components at facilities or structures infested with *Dreissenid* mussels can be removed and replaced or if backup systems can be used, a response for control or maintenance can be rapid and effective. In accessible areas, mussels can be physically removed by a variety of means, including scraping, suction, pressure washing or pigging. Pigging would not be practical in pipes and conduits with lots of bends or size changes. Suction dredges might be used to remove mussels from bottom sediments. Also, pressures washing with 2,000 to 3,000 psi should remove mussels, but it may take 4,000 to 10,000 psi to remove their byssal fibers (the fibers that they use to attach to hard surfaces). While the byssal fibers may not have to be removed to substantially improve water flow, their presence could allow increased corrosion of metal surfaces by anaerobic bacteria. Physical removal of *Dreissenid* mussels can be labor intensive and time consuming, which may pose problems for completing their removal within necessary facility operational time frames. Once the mussels are removed, they will have to be disposed at a local land fill. The potentially large volume of dead and putrefying mussels must be considered when choosing physical removal.

Dreissenid mussels are susceptible to exposure and desiccation. They are more sensitive to longer exposure times than either higher temperatures or freezing. Dewatering as a control measure may be particularly appropriate for canals. If dewatering is an option, operations should plan on dewatering a facility for a minimum of three weeks in non-freezing temperatures. This can be reduced to about a week if air temperatures can be raised to > 25°C. Freezing will kill mussels within a day although exposure time will need to be increased to a few days if there are clumps of mussels to assure thorough freezing. After a facility is re-inundated, there will still be dead mussel bodies and shells to collect and transport to appropriate land disposal locations.

In projects or systems that cannot be dewatered, consider isolating limited areas for either treatment with hot water or other methods to achieve oxygen deprivation (anoxia). The water temperature needs to reach 33-35 °C to assure a kill and this should be repeated once or twice a year for longer-term applications. For oxygen deprivation to work, the system must be well sealed as the mussels will survive for long periods in low-oxygen environments. Depending on water volume and mussel density, it could take several weeks for a system to go sufficiently anoxic to assure a kill. This can be accelerated if the water is warmer (25 °C) or if certain chemicals, such as hydrogen sulfide gas or sodium metasulfite, are added to eliminate oxygen. Additives should not be used without consideration of their potential impacts in discharge water. As with desiccation, there will be mussel disposal requirements post-treatment.

Table 2. Non-chemical treatments methods for controlling *Dreissenid* mussels (U.S. Bureau of Reclamation 2008).

Method	Life Stage	Effectiveness	Duration of Treatment	Notes
Oxygen starvation	All		2 weeks + @ 0 mg/l	Must isolate population; Useful reservoir management scheme if hypolimnion can be increased
Freezing	Juveniles	100%	2 days @ 0°C	Must dewater system
	Adults		5-7 hours @ -1.5°C	
			under 2 hours @ -10°C	
Desiccation	Juveniles	100%	Immediate @ 36°C	Must dewater system for several days
	Adults		5 hours @ 32°C	
			2.1 days @ 25°C	
Cavitation	All	100%	veligers in seconds @ 10-380 kHz	May affect other species, reduced success in high flows, needs power source
			juveniles in minutes	
			adults in a few hours	
Ultrasound	All	100%	veligers in seconds @ 39-41 kHz	May impact other species, needs power source
			adults in 19-24 hrs	
Vibration	Veligers, juveniles	100%	intermittent @ 200 Hz & 10-100 kHz	Structural integrity may be threatened
UV radiation	All	100%	juveniles -4 hrs	Lethal to many species, effectiveness limited by turbidity and suspended solids
			adults – continuous	
Benthic mats (disposable subsrates)	Juveniles, adults	Up to 99%	9 weeks	Initial tests promising for limited infestations

Bacterial toxin, *Pseudomonas fluorescens* (experimental)	All	95%	6 hours	Low toxicity to other organisms, few treatments needed, not yet available in commercial quantities.
Low frequency sound	Juveniles	Inhibits settling	4 to 12 min @ 20 Hz – 20 kHz	Not lethal, needs power source
Low voltage electricity	Adults	Prevents settling	immediate results @ 8 volt AC	Not lethal, needs power source
Plasma pulse technology	Juveniles, adults	Prevents settling	intermittent high energy pulses	Not lethal, private technology
Manual removal (scraping, mechanical filtration)	Juveniles	Variable	N/A	
	Adults			
Electric field pulse	Juveniles, adults	Lethal to juveniles	seconds	May affect other species, needs power source
		Inhibits adult settling		
Predation	All	Low	Continuous	Harvest of potential predatory species must be limited

Biological Control (U.S. Bureau of Reclamation 2008)
Biological control options are extremely limited at this time. Some diving-ducks (e.g., lesser scaup), crayfish, raccoons, and some fish (e.g., freshwater drum, carp, and some sunfish) will feed on *Dreissenid* mussels. Unfortunately, none of these predators are known to prey on the mussels to the point of controlling populations. Generally, predator animals are not feasible inhabitants within the inner workings of project facilities.

Research is ongoing to determine if any known mussel parasites (e.g., trematodes and annelids) or microbes could be used to control zebra mussels. Research involving a bacterial toxin, *Pseudomonas fluorescens*, is being conducted. Laboratory results at the New York Museum show a potential to kill 100% of zebra mussels and 85% of quagga mussels fed the cultured, dead *Pseudomonas fluorescens*. Progress continues toward commercialization of this bacterial toxin, with an expectation of it being available as early as 2010 (Pers. Comm. Dan Malloy. 2008. Research Coordinator, New York Museum). More information is available on the National Energy Technology Laboratory website:
http://www.netl.doe.gov/technologies/publications/factsheets/project/Proj291.pdf.

Unfortunately, at this time bio-control seems unlikely to provide near term benefits for infested project facilities or open water situations. However, this plan will be updated if organisms are identified that may be useful.

Chemical Control (U.S. Bureau of Reclamation 2008)
Tables 3 and 4 present information on an array of both non-oxidizing and oxidizing chemicals for controlling *Dreissenid* mussels. Chemical controls fall into two general categories, those that are lethal and those that are irritants (generally oxidizing chemicals) that discourage settlement or inhibit respiration, growth, or metabolic function of *Dreissenid* mussels. General information is provided to illustrate possible chemical control options. But, because of their potential impacts on non-target organisms, including species and critical habitats listed for protection by the Endangered Species

Act, prescriptive alternatives will be left for later development and coordination in a water specific rapid response plan. Information about chemical control methods will be periodically updated in this plan, particularly if new, effective chemical products become available.

Lethal chemicals include molluscicides, copper sulfate, and certain metal ions (e.g., potassium). These may be used with or without detoxification and some are proprietary (e.g., Clam-trol). Use of chemicals will also likely require an applicator permit and performance under the auspices of a National Pollutant Discharge Elimination System (NPDES) permit from the Environmental Protection Agency. Copper sulfate and most metal ions are also toxic to other organisms in local water bodies and would have to be contained.

Oxidizing chemicals approved for use in drinking water, such as chlorine, potassium permanganate, ozone, and bromine, are effective in controlling mussels but they also impact non-target organisms and may result in adverse environmental impacts. Sodium hypochlorite (NaOCl) injection systems have been used by the Ontario Power Generation in Canada. Another product, BioBullets, has been developed that uses the encapsulation of an active ingredient (KCl) in microscopic particles of edible material designed for ingestion by mussels. It is also supposed to negatively affect the Asian clam *Corbicula fluminea*.

Table 3. Chemical treatment methods for controlling *Dreissenid* mussels (U.S. Bureau of Reclamation 2008).

Treatment	Target Age	Efficiency	Contact Time, Concentration	Comments
NON-OXIDIZING CHEMICALS				
Copper ions	Veligers	100%	24 hours @ 5 mg/l	Lethal to other aquatic species
Potassium ion (KOH)	All	100%	Less than 10 mg/l	As above
Potassium ion (KH2PO4)	All	100%	continuous @ 160-640 mg/l	As above
Potassium salts (KCL)	Juveniles, adults	Prevent settlement	50 mg/l	Lethal to other mussel species, non-toxic to fish at required dose rate
	All	50%	48 hrs @ 150 mg/l	
		95-100%	3 weeks @ 95 – 115 mg/l	
Chloride salts (Nail,)	Veligers/ juveniles	95-100%	6 hours @ 10,000-20,000 mg/	Low cost, low environmental Impacts, very high dosage rates
Copper sulfate	All	55%	5 hrs 300 mg/l @ 22.5 °C	Lethal to other aquatic species
		40%	5 hrs 100 mg/l @ 22.5° C	
		50%	48 hrs 2 – 2.5 mg/l @ 17 C	
OXIDIZING CHEMICALS				
Chlorine	Veligers	100%	0.25-5mg/l in 1 to 9 days	Lethal to many aquatic species
	All	90%	2.0 mg/l continuous	
	Adults	95%	0.3 mg/l 14-21 days	
	Adults	75%	0.5 mg/l 7 days	
Chlorine dioxide ClO2	Veligers	100%	0.5 mg/l 24 hours	Most successful on veligers
Chloramine	Veligers	100%	1.2 mg/l 24 hours	Less toxic to other aquatic life than chlorine
		95%	1.5 mg/l continuous	
Hydrogen peroxide	Veligers	100%	6 hours	High dosage rates required. Lethal to other

	Juveniles			aquatic species
Ozone	All	100%	Veligers in 5 hours @ .5 mg/l Adults in 7 days @ .5 mg/l	Lethal to other aquatic species
Potassium permanganate	All	90-100 %	2.0 mg/l for 48 hours	Must have high continuous dosage, lethal to other species

Table 4. Non-oxidizing commercial products available as chemical treatment methods for controlling *Dreissenid* mussels (U.S. Bureau of Reclamation 2008).

Treatment	Target Age	Efficiency	Contact Time, Concentration	Comments
QUATERNARY AMMONIUM COMPOUNDS				
Clam-Trol CT 1	All	100% 48 hours after exposure	1.95 mg/l @ 11 °C for 12 hours	More toxic to veligers than adults and more toxic to mussels than to trout
			1.95 mg/l @ 14 °C for 14 hours	
			1.95 mg/l @ 20 °C for 6-14 hours	
Calgon H-130	All	100% after 48 hours	0.85-1.12 mg/l	1.1 mg/l toxic to salmonids, must be deactivated, corrosive, flammable
Macro-Trol 9210	All	100%	5-50 mg/l continuous	Lethal to aquatic organisms, must be detoxified
Bulab 6002	All	100%	2 mg/l 7-10 days	Lethal to fish, especially salmonids
			4 mg/l 5-8 days	
AROMATIC HYDROCARBONS				
Mexel 432	Veliger	Deters veliger settlement	Dose at 1-4 mg/l once a day	96 hr LC 50 for rainbow trout 11mg/l, corrosive
EVAC – endothal formulation	All	100%	0.3-3 mg/l for 5 to 144 hours	Lethal to fish but rapidly degrades, does not bio-accumulate
Bulab 6009	All	100%	2 mg/l 4 to 10 days	96 hr LC 50 for rainbow trout 1,1 mg/l, corrosive
			4 mg/l 3 to 8 days	

Note: Products listed in Table 4 have been approved for aquatic use by EPA if applied according to label instructions by a licensed applicator. They may not be approved by the individual states and must have that approval before they can be applied. The molluscicides have been primarily developed for use at water impoundment and hydropower facilities, treatment facilities, water intake structures, etc. Their use in open water is not generally recommended, but might be possible under certain circumstances.

Other Control Methods

Settlement of *Dreissenid* mussels within water conveyance systems or water use facilities can generally be deterred by providing flows that exceed 1.5 meters per second. However, corners, short radius bends and pipe joints or other "edges," including roughened pipe walls from scaling can become inhabited by mussels (Jenner and Janssen-Mommen 1989 and O'Neill 1996). Similarly, the application of anti-fouling coats (e.g, copper-based paints and over-lays of copper on exterior metal surfaces) has shown some success at deterring settlement by all life stages of *Dreissenid* mussels. Generally these surfaces create an irritant to the fouling organism, so it is reluctant to attach, and in some cases the coatings can be toxic to the fouling organism (O'Neill 1996).

The application of extremely low frequency electromagnetic fields within industrial water transport systems may be an effective method for the control of a *Dreissenid* infestation, since zebra mussels showed mortality within 5 days using this procedure (Matthews 1998). Research is believed to be continuing on this methodology at Purdue University-Calumet.

Reservoir management schemes that draw water from the oxygenated epilimnion, increasing the anoxic zone of the hypolimnion, can be utilized to manage *Driessenid*

populations. The mussels in the lower, anoxic zone die from oxygen deprivation. Winter draw-downs also provide opportunity to freeze exposed reservoir literal zones, killing huge population segments of *Dreissenid* mussels. This approach requires significant consideration for safeguarding a water body's fishery, and it does not cause a 100% kill of *Dreissenid* mussels, but it does provide some degree of population management.

Decontamination of Boats and Construction Equipment

Equipment (e.g., boats, recreational equipment and construction equipment) exposed to waters infested with *Dreissenid* mussels should be decontaminated before being moved from the infested water. The 2008 Utah Legislature passed the Aquatic Invasive Species Interdiction Act (Senate Bill 238) and subsequently the Utah Wildlife Board passed associated rule (R657-60, Aquatic Invasive Species Interdiction), both with a purpose to define procedures and regulations designed to prevent and control the spread of aquatic invasive species, particularly *Dreissenid* mussels, within the State of Utah. It is unlawful to possess or transport *Dreissenid* mussels within the State of Utah. Additionally, all boats having been used anywhere within the last 30 days on a *Dreissenid* mussel infested water, either marine or fresh, and subsequently launching on any waters in Utah must certify prior to launch that they have been properly decontaminated. Launch is denied until certification can be met. The only two accepted decontamination protocols in Utah as per Rule R657-60 are as follows:

Do-it-yourself Decontamination

- Clean all plants, fish, mussels and mud from boat or equipment before leaving water body area (discard unused bait in the trash where you fished);
- Drain all water from boat (equipment storage areas, ballast tanks, bilge, live wells and motor) before leaving water body area;
- Dry boat and equipment at home or at suitable storage area (7 days summer, 18 days spring and fall, and 30 days winter or expose boat and equipment to freezing conditions for a continuous 72 hour period) prior to another launch.

Professional Decontamination

- Use a professional to apply scalding water (140^0 Fahrenheit) to wash equipment, boat and trailer and to flush equipment storage areas, ballast tanks, bilge, live wells and motor or other raw water circulation systems.

Either of the aforementioned decontamination protocols for boats and equipment will kill the aquatic invasive species either already inhabiting Utah or threatening to arrive, including adult, juvenile and microscopic life forms (Pers. Comm. 2008. Larry Dalton, Aquatic Invasive Species Coordinator, Utah Division of Wildlife Resources).

Literature Cited:

Claudi, R. and G. L. Mackie. 1994. Practical manual for zebra mussel monitoring and control. Lewis Publishers, CRC Press, Boca Raton, Florida.

Jenner, H. A. and J. P. M. Janssen-Mommen. 1989. Control of zebra mussel in power plants and industrial settings. In: Proceedings of the Zebra Mussel in the Great Lakes, Second International Conference, November 1989, Rochester, N.Y.

Jenner, H. A. and J. P. M Janssen-Mommen. 1993. Zebra mussels: Biology, impacts, and control, Lewis Publishers, Boca Raton, Florida.

Carlton, J. and L. Johnson. 1993. Dispersal of the zebra mussel *Dreissena polymorpha:* the potential role of transient boating activities as a vector of overland spread. In: Proceedings of the Third International Zebra Mussel Conference, February 1993, Toronto, Ontario.

Claxton, W. T. and G. L. Mackie. 1998. Seasonal and depth variations in gametogenesis and spawning of *Dreissena polymorpha* and *Dreissena bugensis* in eastern Lake Erie. Can. J. Zool. 76: 2010-2019.

Claxton, W. T., Mackie G. L. and E. G. Boulding. 1998. A genetic and morphological comparison of deep and shallow water populations of the introduced *Dreissena polymorpha* and *Dreissena bugensis*. Can J. Zool. 76: 1269-1276.

Matthews, R. F. 1998. Extremely Low Frequency Electromagnetism: An Effective Nonchemical Method for Control of Zebra Mussel Infestation. Purdue University-Calumet. In: Abstracts from the Eighth International Zebra Mussel and Other Nuisance Species Conference, Sacramento California March 16-19, 1998.

Mackie, G. L. and B. W. Kilgour. 1993. Efficacy and role of alum in removal of zebra mussel veliger larvae from raw water supplies. In: Proceedings of the Third International Zebra Mussel Conference, February 1993, Toronto, Ontario.

MacNeill, D. B. 1990. Perspectives on salinity tolerances of *Dreissena polymorpha*. Dreissena polymorpha Information Review1(1):3.

Marelli, D. C. and S. Gray. 1983. Conchological redescriptions of *Mytilopsis sallei* and *Mytilopsis leucophaeata* of the brackish Western Atlantic (Bivalvia: Dreissenidae). Veliger 25: 185-193.

McCauley, R. W. and E. Knott. 1993. Lethal effects of hydrogen ions on adult zebra mussels, *Dreissea polymorpha*, in relation to calcium concentration of the surrounding water. In: Proceedings of the Third International Zebra Mussel Conference, February 1993, Toronto, Ontario.

McMahon, R. F. and T. A. Ussery. 1995. Thermal tolerance of zebra mussels (*Dreissena polymorpha*) relative to rate of temperature increase and acclimation temperature, U.S. Army Engineer Waterways Experiment Station, Technical Report EL-95-10, Vicksburg, Mississippi.

Mills, E. L., Rosenberg, G., Spidle, A. P., Ludyanskiy, M., Pligin, Y. and B. May. 1996. A review of the biology and ecology of the quagga mussel (*Dreissena bugensis*), a second species of freshwater Dreissenid introduced to North America. American Zoologist 36:271-286.

Nichols, S. J. and M. G. Black**.** 1994. Identification of larvae: the zebra mussel *(Dreissena polymorpha),* quagga mussel *(Dreissena rostriformis bugensis),* and Asian Clam *(Corbicula fluminea)*. Canadian Journal of Zoology 72:406-417.

Oliver, P. G., Holmes, A. M. and C. Mettam. 1998 *Mytilopsis leucophaeta*, (Conrad 1831) (Bivalvia: Dreissenoidea), a species new to the British fauna. Journal of Conchology 36: 13-18.

O'Neill, C. R. Jr. 1996. The Zebra Mussel—Impacts and Control. New York Sea Grant, Cornell University, State University of New York. Cornell Cooperative Extension Information Bulletin 238. 62 pp.

Pathy, D. A. and G. L. Mackie. 1993. Comparative shell morphology of *Dreissena polymorpha*, *Mytilopsis leucophaeata*, and the "quagga" mussel (Bivalvia, Dreissenidae) in North America. Canadian Journal of Zoology 71:1012-1023.

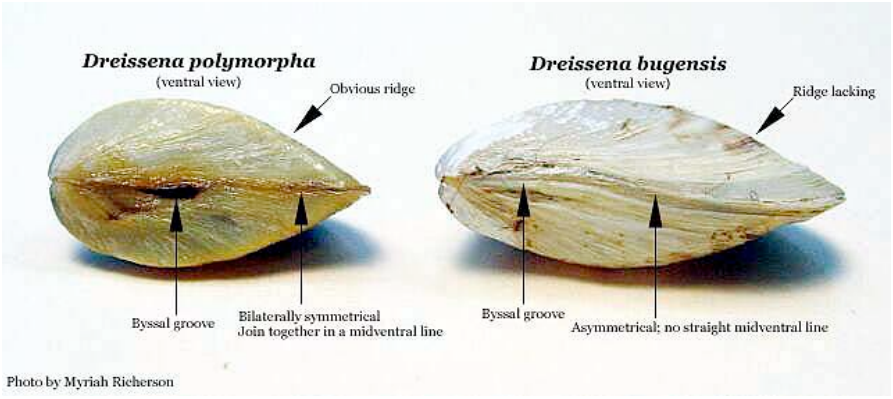
Siddall, S. E. 1980. Early development of *Mytilopsis leucophaeata* (Bivalvia, Dreissenacea). Veliger 22: 378-379.

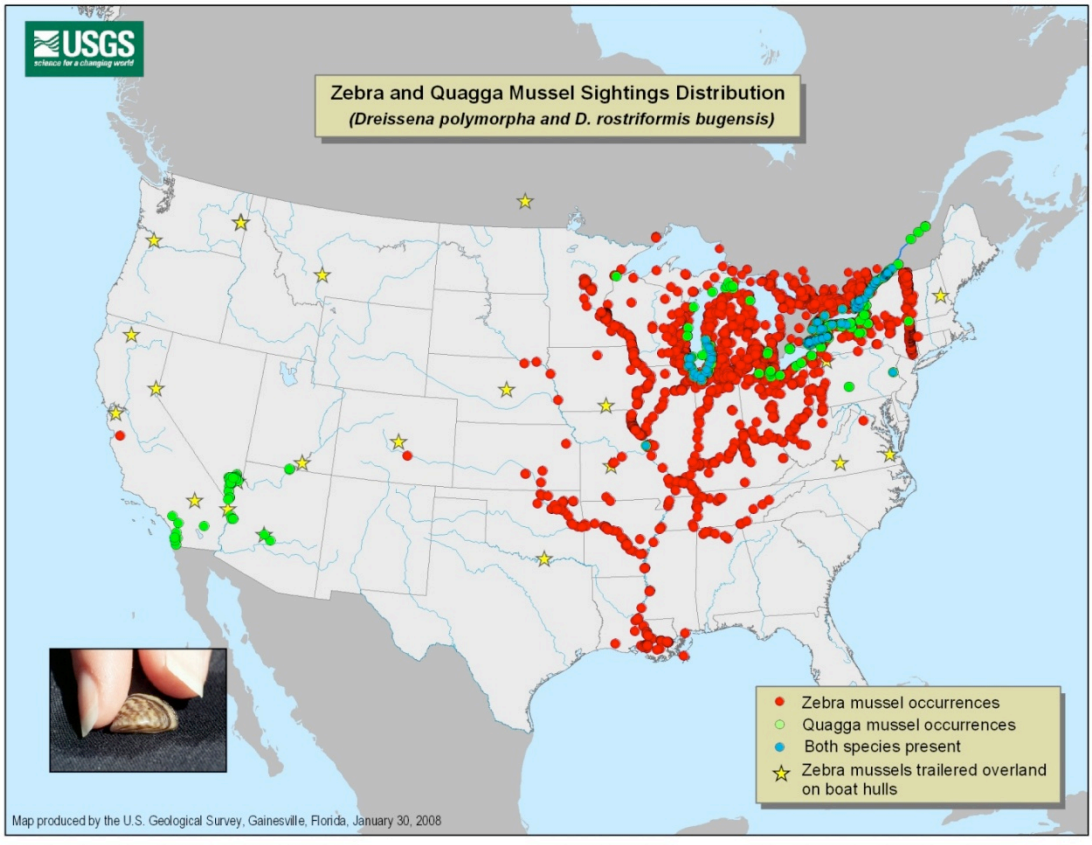
Smith, D. G. and K. J. Boss. 1996. The occurrence of *Mytilopsis leucophaeata* (Conrad, 1831) (Veneroida, Dreissenidae) in Southern New England. Veliger 39: 259-360.

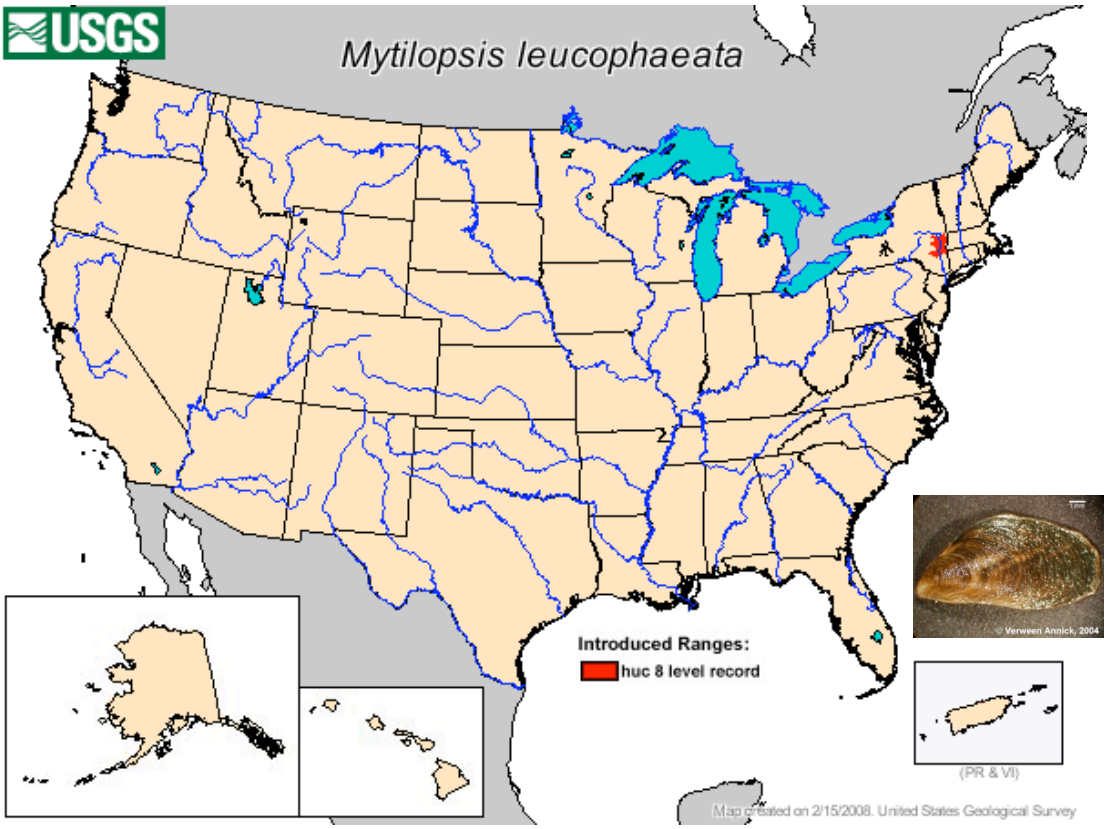
Snyder, F. L., Hilgendorf M. B., and D. W. Garton. 1997. Zebra Mussels in North America: the invasion and its implications! Ohio Sea Grant, Ohio State University, Columbus.

U.S. Bureau of Reclamation. 2008. Draft Upper Colorado Region Prevention and Rapid Response Plan for Dreissenid Mussels.

Verween, A., Vincx, M., Mees, J. and S. Degraer. 2005. Seasonal variability of *Mytilopsis leucophaeata* larvae in the harbour of Antwerp: implications for ecologically and economically sound biofouling control. Belgian Journal of Zoology 135: 91-93.


Dreissena polymorpha
(ventral view)
Obvious ridge
Byssal groove
Bilaterally symmetrical
Join together in a midventral line
Dreissena bugensis
(ventral view)
Ridge lacking
Byssal groove
Asymmetrical; no straight midventral line
Photo by Myriah Richerson


USGS
science for a changing world
Zebra and Quagga Mussel Sightings Distribution
(Dreissena polymorpha and D. rostriformis bugensis)
Zebra mussel occurrences
Quagga mussel occurrences
Both species present
Zebra mussels trailered overland on boat hulls
Map produced by the U.S. Geological Survey, Gainesville, Florida, January 30, 2008


USGS
Mytilopsis leucophaeata
Introduced Ranges:
huc 8 level record
(PR & VI)
Map created on 2/15/2008. United States Geological Survey
© Verween Annick, 2004

New Zealand Mudsnail *Potamopyrgus antipodarum*

Ecology: *P. antipodarum* is a small (<5mm) invasive, hydrobiid snail. It has an elongate, dextral shell that varies in color and typically has 5 to 6 whorls at maturity (Gustafson 2005). New Zealand mudsnail are able to invade and grow in a wide range of ecological habitats. They are found in rivers, reservoirs, lakes and estuaries, and they are able to adapt to a wide range of temperature, salinities and substrates (Zaranko et al. 1997; Richards et al. 2001; Hall et al. 2003). New Zealand mudsnail are not able to withstand freezing temperatures at any salinity (Hylleberg and Siegismund 1987). The highest densities of New Zealand mudsnails typically occur in systems with high primary productivity, constant temperatures and constant flow (Gustafson 2005).

Reproductive, behavioral and morphological adaptations have made New Zealand mudsnail an ideal, aggressive AIS. Their rapid spread is attributed to high reproductive and growth rates, parthenogenesis and lack of parental care. A single female can theoretically produce up to 3.125 x 108 snails in one year. The ability for this species to reproduce asexually means that it is possible for a single individual to produce a new population (Zaranko et al. 1997). The presence of an operculum also allows them to survive for several weeks out of water (Bowler 1991).

New Zealand mudsnail are shown to negatively impact the aquatic communities they invade. Hall et al. (2003) found New Zealand mudsnail population densities that exceeded 100,000 individuals per square meter, and they consumed 75% of the gross primary production. New Zealand mudsnails outcompete native invertebrates for food and space and have also been shown to contribute to weight loss in fish when consumed (Bowler 1991; Vinson and Baker 2007). There is also concern that the high densities of New Zealand mudsnail could produce biofouling in facilities that become infested (Zaranko et al. 1997).

Distribution: *P. antipodarum* has spread from New Zealand to freshwater environments throughout the world. This species current distribution includes: Australia, Europe, Asia and North America. First discovered in the United States in 1987 in the Snake River near Hagerman, Idaho, New Zealand mudsnail are now locally abundant in western rivers (Bowler 1991; Dybdahl and Kane 2005). In Utah (Figure 1), New Zealand mudsnail are found in most of the major river drainages of the northern part of the state and in the Green River (Gustafson 2005; Harju 2007). Ongoing investigation by Utah Division of Wildlife Resources' AIS biologists have discovered additional populations during 2008, showing that the species is moving via stream flows, irrigation flows and on the soles of anglers boots (Pers. Comm. Larry Dalton. 2008. Aquatic Invasive Species Program Coordinator, Utah Division of Wildlife Resources).

Pathways of Introduction: The original source of introduction is unknown, though it is speculated that New Zealand mudsnail was introduced through the commercial transport of aquaculture products (Bowler 1991). Since introduction, both active and passive transport methods have contributed to its spread. New Zealand mudsnail have been shown to spread independently upstream through locomotion. Passive spread by birds, through the alimentary canal of fish, and contaminated recreational equipment is also

documented (Haynes et al. 1985; Richards et al. 2004; New Zealand Mudsnail Management and Control Plan Working Group 2006).

Management considerations: Spread of New Zealand mudsnail can be prevented through increased public education efforts. New Zealand mudsnail have no resistant stage or adhesive structures like other aquatic nuisance species and simple preventative measures can reduce their likelihood of spread to new areas. Once established, however, New Zealand mudsnail are extremely difficult to remove. The spread of New Zealand mudsnail into new watersheds is primarily through water distribution systems, unintentional human transport on contaminated recreational equipment, water containers and bait buckets (Richards 2002). Desiccation and freezing may be used to decontaminate angling and other recreational equipment that comes in contact with water, but this method can be slow, taking up to 24 hours. A faster (less than 30 minutes) and more effective alternative is to spray or immerse gear in disinfectant baths of: copper sulfate, benzethonium chloride, Formula 409® or Sparquat® (Hosea and Finlayson 2005; New Zealand Mudsnail Management and Control Plan Working Group 2006).

Possible control methods of existing populations include periodic: molluscicide application, desiccation of the waterbody, and introduction of a biological control agent. GreenClean® is a non-copper-based algaecide that has been successful at killing New Zealand mudsnail in lab experiments and is being tested for field applications (New Zealand Mudsnail Management and Control Plan Working Group 2006). Biocontrol lab trials using a trematode parasite from the native range of New Zealand mudsnails have been positive so far (Dybdahl et al. 2005), though this method of control is currently unavailable.

Literature Cited:

Bowler, P. 1991. The rapid spread of the freshwater hydrobiid snail *Potamopyrgus antipodarum* (Gray) in the middle Snake River, southern Idaho. Proceedings of the Desert Fishes Council 21:173-182.

Dybdahl, M.F. and S.L. Kane. 2005. Adaptation vs. phenotypic plasticity in the success of a clonal invader. Ecology 86(6):1592-1601.

Gustafson, D. 2005. New Zealand mudsnail in the western USA. Montana State University. Available: http://www.esg.montana.edu/aim/mollusca/nzms/. (February 2008).

Hall, R., J.L. Tank and M.F. Dybdahl. 2003. Exotic snails dominate nitrogen and carbon cycling in a highly productive stream. Frontiers in Ecology and the Environment 1(8):407-411 .

Harju, T. 2007. Modeling regional distribution and local food web dynamics of the new zealand mud snail (*Potamopyrgus antipodarum*). Master's thesis. Utah State University, Logan, Utah.

Haynes, A., B. Taylor and M. Varley. 1985. The influence of the mobility of *Potamopyrgus jenkinsi* on its spread. Archiv. fur de Hydrobiologia, 103:497-508.

Hosea, R. and B. Finlayson. 2005. Controlling the spread of New Zealand mudsnails on wading gear, California Department of Fish and Game Administrative Report 2005-02, Rancho Cordova, California.

Hylleberg, J. and H. Siegismund. 1987. Niche overlap in mud snails (Hydrobiidae: freezing tolerance. Marine Biology 94:403-407.

New Zealand Mudsnail Management and Control Plan Working Group. 2007. National Management and Control Plan for the New Zealand Mudsnail (*Potamopyrgus antipodarum*).

Richards, D. 2002. The New Zealand mudsnail invades. Aquatic Nuisances Species Digest 4(4):42-44.

Richards, D., L. Cazier and G. Lester. 2001. Spatial distribution of three snail species including the invader *Potamopyrgus antipodarum* in a freshwater spring. Western North American Naturalist 1(3):375-380.

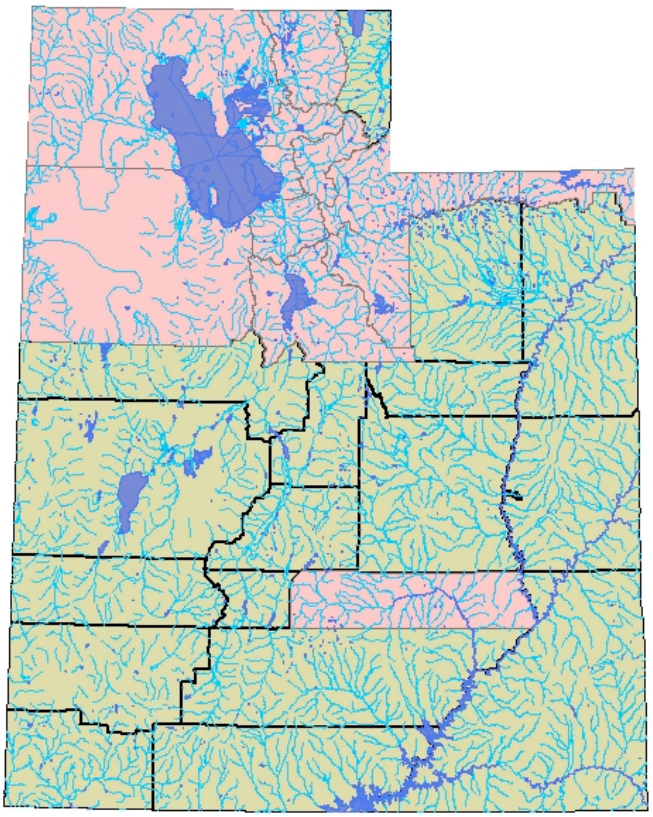
Richards, D., P. O'Connell and D. Shinn. 2004. Simple Control Method to Limit Spread of New Zealand mudsnail, *Potamopyrgus antipodarum*. North American Journal of Fisheries Management 24:114-117.

Vinson, M. and M. Baker. 2007. Poor growth of rainbow trout (*Oncorynchus mykiss*) fed New Zealand mudsnails (*Potamopyrgus antipodarum*). North American Journal of Fisheries Management (Accepted August 2007).

Zaranko, D., D. Farara, D. and F. Thompson. 1997. Another exotic mollusc in the Laurentian Great Lakes: the New Zealand native *Potamopyrgus antipodarum* (Gray 1843) (Gastropoda, Hydrobiidae). Canadian Journal Of Fisheries and Aquatic Sciences 54:809-814.

New Zealand Mudsnail

Major Waterways
NZMS_Present



Daniel L. Gustafson
Montana State University

Red-rimmed Melania *Melanoides tuberculatus*:

Ecology: This is a small, aquatic, herbivorous snail, consuming detritus and benthic microalgae. Adult snails typically attain a shell length of between 30 and 36 mm, however, lengths up to 80 mm have been reported (Murray 1975). It has an elongated conical shell with regularly increasing whorls. Five whorls typically make up the shell. There are prominent vertical ribs present on the middle and upper whorls. The spiral of the shell is usually twice the length of the aperture or more. Shell coloration is usually light brown, frequently mottled with rust colored spots that may form a spiral below the suture (GSMFC 2007).

Red-rimmed Melania is very common throughout its native range in both Africa and Asia. It prefers shallow, slow running water (0.6 - 1.2 cfs) (GSMFC 2007). This snail tolerates a wide range of saline environments and can be found in fresh water as well as estuarine environments up to 30 ppt (Roessler et al. 1978). The temperature tolerance for this snail is believed to be restricted in the U.S. to 18 - 25 degrees Celsius (Murray 1971). The prime habitat for this species consists of areas rich in detritus and silt, behind overhanging stems and protruding roots of bank vegetation. They are active mostly at night, hiding beneath decaying plants and stones or burying themselves in the mud during the day (Livshits and Fishelson 1983).

Red–rimmed Melania reproduce both sexually and through parthenogenesis (Livshits et al. 1984). Individual snails as small as 10 mm are able to reproduce (GSMFC 2007). This species is viviparous (Livshits and Fishelson 1983), holding up to 70 offspring in a brood pouch. Young remain in the brood pouch until released at 1 - 2 mm in length (GSMFC 2007).

Red-rimmed Melania are also a vector for several important diseases. They are the intermediate host for a number of trematode parasites including: *Clonorchis sinensis*, the Chinese liver fluke; *Paragonimus westermani*, the Oriental lung fluke; *Diorchitrema formosanum*, an intestinal trematode; *Opisthorchis sinensis*, the human liver fluke; and *Philophthalmus sp*., the avian eye fluke (GSMFC 2007).

Distribution: *M. tuberculatus* is native to subtropical and tropical regions of northern and eastern Africa and southern Asia, from Morocco and Madagascar to Saudi Arabia, Iran, Pakistan, India, southern China, and Indonesia east to Java and the Celebes (Power et al. 2006). In the United States, *M. tuberculatus* is widely distributed throughout the Gulf of Mexico.

Pathways of Introduction The original method of introduction for *M. tuberculatus* to the United States was through the aquarium trade. A San Francisco aquarium dealer introduced it into California prior to 1937. It was then introduced into Tampa Bay, Florida after purchase from the same San Francisco aquarium dealer (Roessler et al. 1978). It is likely that it was spread to Utah and the rest of the Great Basin through the aquarium trade. There are a number of springs throughout the Great Basin that either have Red-rimmed Melania or represent suitable habitat (Don Archer, Utah Division of

Wildlife Resources). Fisherman using felt-soled waders as they move from one site to the next, without decontaminating their equipment, could continue to spread this species throughout Utah.

Management Consideration: Once these snails have been introduced into a new body of water it is difficult to remove them. They compete with native gastropods for resources (Roessler et al. 1977) and could eventually displace them. The best method for preventing the spread of this species into new waters is to decontaminate all equipment that has come in contact with infested waters. This can be done with scalding hot water (Mitchell and Brandt 2003). Educating the public on the risks of this species, as well as how to prevent the spread, is the most effective way of keeping this species out of new waters.

Literature Cited:

Gulf States Marine Fisheries Commission. 2007. *Melanoides tuberculata* (Müller, 1774). Available: http://nis.gsmfc.org/nis_factsheet.php?toc_id=144. (February 2008).

Livshits, G., and L. Fishelson. 1983. Biology and reproduction of the freshwater snail *Melanoides tuberculata* (Gastropoda: Prosobranchia) in Israel. Israel Journal of Zoology 32:21-35.

Livshits, G., Fishelson, L., and G. S. Wise. 1984. Genetic similarity and diversity of parthenogenic and bisexual populations of the freshwater snail *Melanoides tuberculata* (Gastropoda: Prosobranchia). Biological Journal of the Linnean Society 23:41-54.

Mitchell, A.J., Brandt, T.M. 2003. Temperature tolerance of Red-rimmed Melania, *Melanoides tuberculata*, (Gastropoda: Prosobrachia: Thiaridae). World Aquaculture Society Meeting. 2003:192.

Murray, H.D. 1971. The introduction and spread of thiarids in the United States. The Biologist 53:133-135.

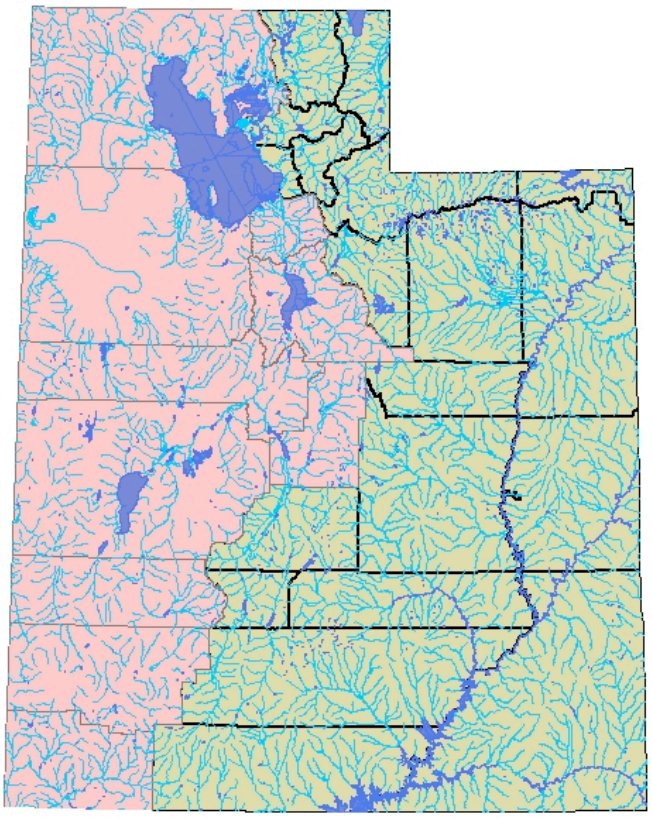
Murray, H.D. 1975. *Melanoides tuberculata* (Müller), Las Morras Creek, Bracketville, Texas. Bulletin of the American Malacological Union, Inc. 1975:43.

Power, A., M. Mitchell, R. Walker, M. Posey, T. Alphin and C. Belcher. 2006. Baseline port surveys for introduced marine molluskan, crustacean and polychaete in the South Atlantic Bight. Available: marsci.uga.edu/gaseagrant/pdf/Port_Survey.pdf. (February 2008).

Roessler, M.A., G. L. Beardsley, and D. C. Tabb. 1977. New records of the introduced snail, *Melanoides tuberculata* (Mollusca: Thiaridae) in south Florida. Florida Scientist 40:87-94.

Red-rimmed Melania

Counties with Red-rimmed Melania Present
Major Waterways



CRUSTACEANS

Crayfish:
Northern crayfish *Orconectes virilis*
Louisiana crayfish *Procambarus clarkii*
Water nymph crayfish *Orconectes nais*
Rusty crayfish *Orconectes rusticus*
Utah is inhabited by a single native crayfish known as the Pilose crayfish *Pacifastacus (Hobbsastacus) gambelii*. Its native range is in northern Utah's Bear River, Weber River and Ogden River drainages and in the Raft River Mountain's drainages. Isolated populations, also, persist in Salt Creek, east of the Great Salt Lake. None of the invasive species of crayfish found in Utah are known to overlap its range (Figure 1). Crayfish are not native to the Colorado Plateau (Dean 1969) or to the Bonneville basin south of Utah County (Johnson 1986), including the Sevier River Drainage. Two other species of *Pacifastacus* are native to states adjoining Utah: *Pacifastacus leniusculus* in Nevada and *Pacifastacus (Hobbsastacus) connectens* in Idaho (Pennak 1978). Both may be native to Utah waters, however, this possibility has yet to be confirmed (Johnson 1986). The signal crayfish *Pacifastacus leniusculus* is present in Utah County, and may have been introduced there (Johnson 1986).

Unfortunately, two known invasive crayfish, the northern crayfish *Orconectes virilis*, and Louisiana crayfish *Procambarus clarkii* are found in Utah (Figure 1). These invasive crayfish are both considered AIS.

The water nymph crayfish *Orconectes nais* and the rusty crayfish *Orconectes rusticus* do not currently inhabit Utah, but each are AIS that threaten to arrive. *O.nais* has heavily infested Colorado waters, and due to its distribution on the western slope of Colorado, *O. nais* has potential to invade Utah waters. *O. rusticus* poses a threat due to its wide North American distribution. Both are popular among anglers as bait, which represents a pathway for potential movement to Utah. This document does not further address either of these two AIS, although management considerations are the same as those discussed for all crayfish.

Northern Crayfish *Orconectes virilis*
Distribution:
This AIS is found in association with Scofield Reservoir and the lower Price River; Huntington North Reservoir and lower Huntington Creek; Strawberry and Starvation Reservoir's lower Strawberry River and Duchesne River; Yellowstone River and Uinta River. It is also found along the full length of Lake Powell on the Colorado River, including the San Juan River arm. This crayfish inhabits the Santa Clara River and Virgin River, downstream into Arizona and Nevada, which discharges to the Colorado River. A limited population persists in New Castle Reservoir of Iron County, too. Limited populations persist in the Great Salt Lake Valley along the lower Ogden River and Weber River reaches. Another population persists in Tooele County's Grantsville Reservoir south of the Great Salt Lake. And, a limited population persists along the lower Provo

River between Deer Creek Reservoir and Utah Lake. The lower elevation distribution seemingly is limited by rising salinity levels in the water (Figure 1).

Louisiana crayfish *Procambarus clarkii*
Distribution: *P. clarkia* can be found in Tooele County's western basin drainage near St. John (Figure 1).

Pacific crayfish *Pacifastacus leniusculus*
Distribution: *P. leniusculus* is found in the Salem Pond and Spring Pond along the southeast side of Utah Lake between Santaquin and Payson (Figure 1).

Description: All of the crayfish look much alike, although there certainly are subtle differences in color hues. *P. leniusculus* seems to be the largest, reaching lengths of 12 to 16 cm; *O. virilis* reaches lengths of 10 to12 cm; and *P. clarkia* can grown to about 5.5 to 12 cm in length (Collicut 1998).

Ecology: Crayfish eat aquatic plants--they have been used to clear weeds from ponds on fish farms (Griffiths et al. 2004); invertebrates such as snails and insects; tadpoles and small fish. Generally, they are opportunistic omnivores, but they mostly obtain their food by scavenging dead animals and detritus. Crayfish can be cannibalistic or prey on individuals of other crayfish species (Ilhéu and Bernardo 1993, Guan and Wiles 1997, Nystrom 1999a and 1999b, Lewis 2002).

O. virilis can mate in autumn or in spring, but the eggs are not fertilized and laid until spring. Eggs are attached under the female's tail to swimmerets in a large ball resembling a raspberry, and they hatch one to two months after they are laid. Young hatchlings look like miniature adults and can probably grow to about 2-3 cm long by the fall. *O. virilis* has a short lifespan; males and females usually die when they are about 2 years old. Males dies after mating and females die after their young hatch. Occasionally they are known to live longer, but it's thought that none survive beyond their 4th spring (Collicut 1998).

P. clarkii has been known to incubate eggs or carry young throughout the year (Lindqvist and Huner 1999). This allows reproduction at the first available opportunity, which contributes to colonization success (Huner 1999, Gutierrez-Yurrita et.al. 1997, Gutierrez-Yurrita and Montes 1999). Newly hatched young remain with their mother in the burrow for up to eight weeks and undergo two moults before they can fend for themselves (Ackefors 1999). Breeding males are known to move up to 17 km in four days and cover a wide area, which helps dispersion (Barbaresi and Gherardi 2000). *P. clarkii* is able to tolerate dry periods of up to four months (Huner 1999, Ackefors 1999), and is able to occupy a wide variety of habitats, including subterranean situations, wet meadows, seasonally flooded swamps and marshes, and permanent lakes and streams. *P. clarkii* thrives in warm, shallow wetland ecosystems, including sluggish streams and lentic situations where low oxygen levels and high temperatures exist. It is one of few North American crayfish with tolerance for saline waters (NatureServe 2003).

P. leniusculus typically mates and lays eggs during October; hatching occurs from late March to the end of July depending on temperature. *P. leniusculus* occupies a wide range of habitats from small streams to large rivers and natural lakes, including sub-alpine lakes (Lowery and Holdich 1988, Lewis 2002). *P. leniusculus* also grows well in culture ponds, and it tolerates brackish water and high temperatures, but it does not occur in waters with a pH lower than 6.0. *P. leniusculus* is very active, migrating up and down rivers, however, its rate of colonization is relatively slow and may only be about 1 km/yr. This species can be very long lived, with specimens known to survive 16 to 20 years (Stebbing et al. 2003). Their burrows are known to have a serious impact on bank morphology, causing them to collapse (Guan 1994, Sibley 2000).

Impacts: Crayfish introductions can negatively impact ecosystems and cause economic damage. When crayfish are introduced into a suitable habitat it is typical that they become quickly established, and as a result dramatic changes occur in native plant and animal communities (Schleifstein and Fedili 2003). For example, *P. clarkii* has contributed to the decline of some native European crayfish by introducing interspecific competition pressure and acting as a vector for the transmission of the crayfish fungus plague *Aphanomyces astaci*. This crayfish has also been associated with the crayfish virus *vibriosis* in crayfish farms, and is an intermediate host for numerous helminth parasites of vertebrates (Thune et al. 1991; Holdich 1999; Holdich, Gydemo and Rogers 1999; Holdich, Rogers and Reynolds 1999). Bowen (2003) indicated that *O. rusticus* has a very high rate of metabolism, and it could potentially eat twice as much as *O. virilis*, damaging macrophyte populations. *O. rusticus* often displaces native crayfish species. *P. leniusculus* continues to spread in Great Britain, and may well cause the extinction of their single indigenous crayfish species within the next 30 years (Hiley 2003 and Sibley 2003). Nonnative crayfish infestations also reduce the functionality of freshwater habitats in which they become established by consuming invertebrates and macrophytes, and degrading river banks through burrowing activity (Holdich 1999). Potential negative effects of non-native crayfish include the following (Godfrey 2002):

- Competition for food and space with resultant displacement of native crayfish;
- Transfer of disease;
- Consumption of wild fish eggs with resultant reduction of fish stocks;
- Consumption of large amounts of macrophytes, having indirect and direct effects on other invertebrates;
- Clouding the water with suspended solids due to their digging and swimming activity, which reduces photosynthesis by macrophytes; and
- Destabilizing ditches, canals, and stream banks.

Pathways For Invasion or Spread:

- Aquaculture (Huner 1999, Washington Department of Fish and Wildlife 2003)
  Note[1]: *P. leniusculus* was first introduced into Japan from North America for use as food in 1928.
  Note[2]: Crayfish are harvested from natural waters by commercial fishers and cultivated in small earthen ponds from which they can escape or simply be introduced into other waters.

Note[3]: *P. clarkii* is a popular dining delicacy, accounting for the vast majority of crayfish commercially produced in the United States.

- Anglers
  Note[1]: Crayfish are popular among anglers as bait, allowing inadvertent spread.
  Note[2]: Crayfish are popular among anglers as a fun and tasty catchable food; so anglers purposely spread them to waters they desire to fish.
- Natural dispersal (Huner 1999, Nature Serve 2003, Washington Department of Fish and Wildlife 2003)
  Note[1]: *P. clarkii* as a bait for largemouth bass is believed to be causative for their introduction into the State of Washington.
  Note[2]: There are reports of migrations by male crayfish over several miles in comparatively dry areas, especially in the rainy season.
- Aquarium Trade (Huner 1999, Holdich 1999, Holdich, Gydemo and Rogers 1999, Holdich, Rogers and Reynolds 1999)
  Note[1]: Sales of live *P. clarkii* as an educational prop for teachers and students, as a aquarium or garden pond pet, or as food for predaceous aquarium fish may have accelerated their spread, especially due to aquarium dumps when an owner tires of the hobby or no longer has a use for the crayfish.
  Note[2]: The crayfish that now occur in African freshwaters are thought to have been introduced by smugglers without the knowledge and permission of the relevant authorities (Holdich 1999; Holdich, Gydemo and Rogers 1999; Holdich, Rogers and Reynolds 1999).

Management and Control:
The best method of control is to prevent their initial introduction.

Law enforcement efforts (legislation for effective laws and follow-up patrols) designed to prevent the spread of crayfish has proven difficult, since many people intentionally spread crayfish to enhance their recreational sport of cray-fishing. Educating anglers, aquarium sales staff, crayfish trappers, bait dealers, and teachers about the threats posed by invasive crayfish will help reduce the risk from expanding populations.

Possible control options include the elimination or reduction of introduced crayfish via mechanical, physical, chemical or biological methods. Treatments can be followed by the restocking of native crayfish populations, when feasible. And, research should consider the development of plague-resistant strains of native crayfish.

- Physical Methods: They include but are not limited to drying (draining of ponds and the diversion of flowing channels) and the construction of barriers (either physical or electrical) to preclude crayfish movement.
  Note[1]: Population reduction may be possible by physical methods, although eradication is unlikely unless the population is particularly restricted in range and size.
  Note[2]: Physical methods have environmental costs, which should be weighed against the environmental benefits of employing them.

- Mechanical methods: They include but are not limited to the use of traps, seine nets, and electro-fishing.
  Note[1]: Continued trapping is preferable to short-term intensive trapping, which may provoke feedback responses in the population such as stimulating a younger maturation age and greater egg production. Also, trapping is size selective, so the smaller individual crayfish remain, taking advantage of the lack of competition to grow rapidly (Sibley 2000).

- Chemical Methods: Biocides such as organophosphate, organochlorine, and pyrethroid insecticides can be used to control crayfish. Individual crayfish are differentially affected depending on their size, with smaller individuals being more susceptible. Another possible chemical solution lies in the potential to use pheromones to enhance trapping success of the AIS crayfish. To date, crayfish-specific or even crayfish species-specific chemical pheromones have yet to be developed, although this technique has been used to control insect populations (Pedigo 1989). Crustaceans do emit pheromones and Stebbing et al. (2003 and 2004) have researched the possibilities of using pheromones to attract male *P. leniusculus* into traps.
  Note[1]: Biocides are not crayfish-specific, so other invertebrates, such as native crayfish and other benthic organisms, may be eliminated along with the AIS crayfish. Re-stocking of target and non-target species needs to be considered.
  Note[2]: There is cause for concern about toxin bioaccumulation and biomagnification in the food chain when using chemical methods, although it is less of a problem with pyrethroids.

- Biological Methods: They include the use of fish predators, disease-causing organisms (that infect only crayfish) and use of microbes that produce toxins; for example the bacterium *Bacillus thuringiensis* var. *israeliensis*. (Holdich, Gydemo and Rogers 1999).
  Note[1]: Only the use of predaceous fish has been used successfully; eels, burbot, perch and pike are predators that are partial to eating crayfish. The amount of cover, type of fish predator used and AIS crayfish location are all important variables in determining the success of such an approach. In general reduced cover is correlated with increased predation rates (Westman 1991; Holdich, Gydemo and Rogers 1999).

Literature Cited:

Ackerfors, H. 1999. The culture and capture crayfish fisheries in Europe. World Aquaculture 29(2): 18-24, 64-67.

Barbaresi S. & F. Gherardi. 2000. The invasion of the alien crayfish *Procambarus clarkii* in Europe, with particular reference to Italy. Biological Invasions 2: 259-264

Bowen. 2003. Rusty Crayfish factsheet Available: http://www.seagrant.umn.edu/ais/rustycrayfish_invader (March 2008)

Collicut, 1998. Biology of Northern Crayfish, Available: http://www.naturenorth.com/fall/crayfish/Fcray.html (March 2008)

Dean, J.L. 1969. Biology of the crayfish *Orconectes causeyi* and its use for control of

aquatic weeds in trout lakes. U.S. Bureau of Sportfisheries and Wildlife, Technical Paper 24.
Gherardi F. and D. M. Holdich (eds.). 1999. Crayfish in Europe as alien species. How to make the best of a bad situation.
Godfrey, L. 2002. UC Pest Management Guidelines . University of California. Available: http://www.ipm.ucdavis.edu/PMG/r682500211.html (March 2008)

Griffiths, S.W., Collen, P. and Armstrong, J.D. 2004. Competition for shelter among over-wintering Signal Crayfish and juvenile Atlantic Salmon, Journal of Fish Biology 65: 436 - 447.
Guan, R.Z. 1994. Burrowing behaviour of the crayfish *Pacifastacus leniusculus* in the River Great Ouse. Freshwater Forum 4, pp. 155–166
Guan, R.Z. and Wiles, P.R. 1997. Home range of the crayfish, *Pacifastacus leniusculus* in a British lowland river. Freshwater Forum 8, pp. 45–54
Gutiérrez-Yurrita P.J.; Montes C. Bioenergetics and phenology of reproduction of the introduced red swamp crayfish, *Procambarus clarkia*. Freshwater Biology, Volume 42, Number 3, November 1999 , pp. 561-574(0)
Gutierrez-Yurrita P.J., G. Sancho, M. A. Bravo, A. Baltanas and C. Montes. 1997. Diet of the Red Swamp Crayfish *Procambarus clarkii* in natural ecosystems of the Donana National Park temporary fresh-water marsh (Spain) Journal of Crustacean Biology, Vol. 18, No. 1 (Feb., 1998), pp. 120-127
Hiley*, P.D.* Conservation Biology 11: 641-647. 2003. The slow quiet invasion of signal crayfish (*Pacifastacus leniusculus*) in England
Holdich, D.M., Gydemo, R. and Rogers, W.D. 1999. A review of possible methods for controlling nuisance populations of alien crayfish. In Gherardi, F. and Holdich, D.M. (eds.) Crustacean Issues 11: Crayfish in Europe as Alien Species (How to make the best of a bad situation?) A.A. Balkema, Rotterdam, Netherlands: 245-270.
Holdich, D.M. 1999. The negative effects of established crayfish populations. In Herardi, F. and Holdich, D.M. (eds.) Crustacean Issues 11: Crayfish in Europe as Alien Species (How to make the best of a bad situation?) A.A. Balkema, Rotterdam, Netherlands: 31-48.
Holdich, D.M., Rogers, W.D. and Reynolds, J.D. 1999. Native and alien crayfish in the British Isles. In Gherardi, F. and Holdich, D.M. (eds.) Crustacean Issues 11: Crayfish in Europe as Alien Species (How to make the best of a bad situation?) A.A. Balkema, Rotterdam, Netherlands: 221-242.
Huner, J. Henttonen. 1999. The introduction of alien species of crayfish in Europe: A historical introduction Crayfish in Europe as Alien Species.
Ilheu, M. and Bernardo, J.M. 1993. Experimental evaluation of food preferences of red swamp crayfish, *Procambarus clarkii*: University of Southwestern Louisiana, LaFayette, LA (USA). pp. 359-364. 1993.
Johnson, J. E. 1986. Inventory of Utah crayfish with notes on current distribution. Great Basin Naturalist. 46: 625-631.
Lewis, S. D. 2002. *Pacifastacus*, in Holdich, D. M. (Ed.), Biology of freshwater crayfish. Blackwell Science, Oxford: 511-540
Lindqvist, O.V. and Huner, J.V. 1999. Life history characteristics of crayfish: What

makes some of them good colonizers? In Gherardi, F. and Holdich, D.M. (eds.) Crustacean Issues 11: Crayfish in Europe as Alien Species (How to make the best of a bad situation?) A.A. Balkema, Rotterdam, Netherlands: 23-31.

NatureServe. 2003. NatureServe Explorer: An online encyclopedia of life [web application].Version 1.8. NatureServe, Arlington, Virginia. Available: http://www.natureserve.org/explorer. (February 2008)

Nystrom, P. 1999a. Ecological impact of introduced and native crayfish on freshwater communities: European perspectives. In Gherardi, F. and Holdich, D.M. (eds.) Crustacean Issues 11: Crayfish in Europe as Alien Species (How to make the best of a bad situation?) A.A. Balkema, Rotterdam, Netherlands: 63-85.

Nystrom P., C. Bronmark, and W. Graneli-Oikos. 1999b. Influence of an exotic and a native crayfish species on a littoral benthic community: European perspectives. In Gherardi, F. and Holdich, D.M. (eds.) Crustacean Issues 11: Crayfish in Europe as Alien Species (How to make the best of a bad situation?) A.A. Balkema, Rotterdam, Netherlands: 23-31.

Pedigo, L.P. 1989. Entomology and pest management. New York: Macmillan Publishing Co.

Pennak, R. W. 1978. Freshwater invertebrates of the United States. John Wiley and Sons, New York.

Schleifstein, M. and Fedeli, D. 2003. Louisiana crawfish invade ponds across the globe. The Times Picayune: Monday April 14, 2003.

Sibley, P. 2000. Signal crayfish management in the River Wreake catchment, in rogers, D. & Brickland, J. (Eds), Crayfish Conference Leeds. Environment Agency, Leeds: 95-108.

Sibley, P. J. 2003. The distribution of crayfish in Britain, in Holdich, D. M. & Sibley, P. J. (Eds), Management & Conservation of Crayfish. Proceedings of a conference held in Nottingham on 7th November, 2002. Environment Agency, Bristol: 64-72.

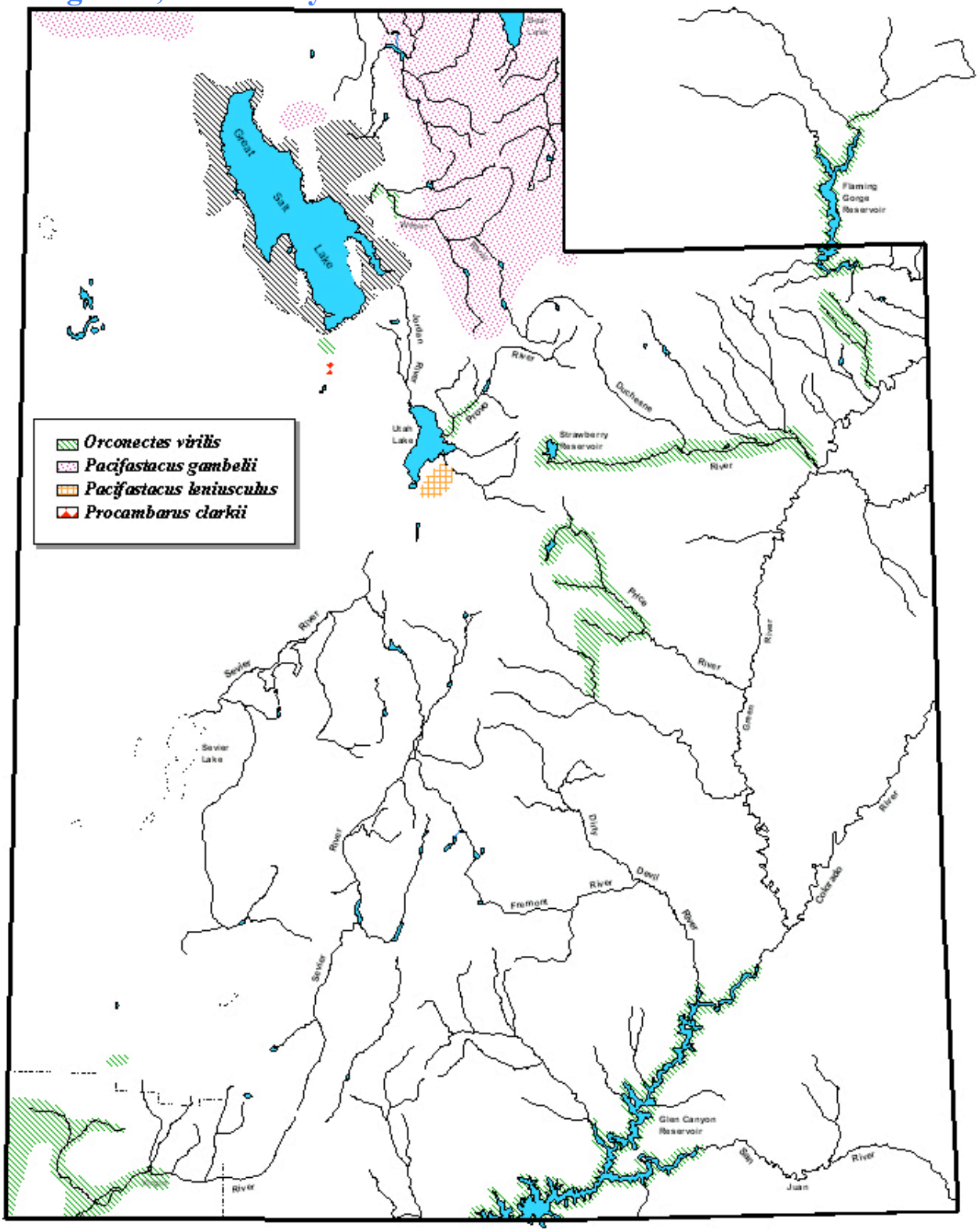
Stebbing, P. D., Bentley, M. G. & Watson, G. J. 2003. Mating behaviour and evidence for a female released courtship pheromone in the signal crayfish *Pacifastacus leniusculus*. Journal of Chemical ecology 29 (2): 463-473.

Thune, R.L., Hawke, J.P., & Siebling, R.J. 1991. Vibriosis in red swamp crayfish Journal of Aquaculture, Animal Health. 3:188-191.

Washington Department of Fish and Wildlife. 2003. Prohibited aquatic animal species: *Procambarus clarkii*. Washington Department of Fish and Wildlife's Aquatic Nuisance Species Classification.

Westman, K. 1991. The crayfish fishery in Finland - its past, present and future. Finn. Fish. Res. 12:187-216.

Figure 1, Utah Crayfish Distribution



Johnson, J. E. 1986.

FISH

Burbot *Lota lota*

Ecology: Burbot are large fish known to grow to as much as 1.5 meters in length and 34 kilograms in mass (Morrow 1980). These fish are yellow, light tan, or brown with dark brown or black patterning on the body, head and most fins. The underbelly and pectoral fins are pale to white (Morrow 1980; Cohen et al. 1990). The first dorsal fin is short and is followed by a long second dorsal fin at least six times the length of the first and joined to a rounded caudal fin (Morrow 1980). Burbot have neither dorsal nor anal spines and have 67 to 96 soft dorsal rays, and 58 to 79 soft anal rays (Cohen et al. 1990). Gill rakers are short, pectoral fins are rounded, and caudal fins have 40 rays (Morrow 1980). Like other cods, burbot are also characterized by a single barbel located on the chin (Morrow 1980; Cohen et al. 1990).

Newly hatched burbot are completely planktivorous, and remain so even when they are no longer gape limited (Ghan and Sprules 1993). Diet of larval burbot is dominated by rotifer species for the first two weeks. Diet then shifts to slightly larger nauplii, changing further during week four to cycloid copepods, daphnia and calanoid copepods (Ghan and Sprules 1993). Juveniles have a diet of molluscs and insect larvae (Tolanen et al. 1999). Adult burbot are piscivorous and diet consists of over 99% fish, by mass, in Lake Superior (Bailey 1972). Though burbot are primarily a piscivorous fish, their diet changes seasonally and in response to competition. After the winter months, Tolanen et al. (1999) found that burbot ate a much higher proportion of aquatic invertebrates, namely crustaceans in the early summer and oppossum shrimp in the fall. In Siberia's Vilyusk Resevoir, their diet overlaps with pike and forces burbot to broaden their diet breadth to include more benthic invertebrates (Kirillov 1988). In addition to fish and invertebrates, Bailey (1972) also found rocks, wood chips, plastic, and other inert materials in burbot stomachs, indicating that burbot feeding habits were somewhat indiscriminate (Bailey 1972; Kirillov 1988; Ghan and Sprules 1993; Tolanen, Kjellmann, and Lappalainen 1999). Burbot are the top predators in their ecosystem, sometimes overlapping with similar top predators such as pike or large salmonids (Kirillov 1988).

Burbot are demersal fish found in deep temperate lake bottoms and slow moving cold river bottoms with temperatures between four and eighteen degrees Celcius (Cohen et al. 1990; Riede 2004). Primarily found at depths ranging from 1 to 700 meters, these fish prefer fresh waters, but are also found in some brackish water systems (Cohen et al. 1990). These fish often dwell among benthic refugia such as roots, trees, rocks and dense vegetation (Scott and Crossman 1973; Morrow 1980; Cohen et al. 1990; Billard 1997; Riede 2004).

Burbot eggs hatch in the spring between April and June, depending on location (Bjorn 1940; Cohen 1990). Incubation time is temperature and population specific and eggs usually take between 30 and 70 days to hatch (Bjorn 1940; MacCrimmon 1959). In four weeks, larval burbot increase in length from less than one centimeter to over two centimeters (Ghan and Sprules 1993). Burbot in Lake Superior exhibited very fast growth rates during the first two growing seasons, and attain 42% of their total length after ten

growing seasons (Bjorn 1940; MacCrimmon 1959; Bailey 1972; Cohen et al. 1990; Ghan and Sprules 1993). In the Vilyuy River Basin, Siberia, burbot attain sexual maturity in their 7th or 8th year, with males usually maturing one year before females (Kirillov 1988). In Lake Superior, burbot as young as one year old were sexually mature (Bailey 1972). Though sexually mature specimens were found for both sexes in year one and older age classes, there was not a high proportion of sexually mature males until year five, when all specimens of both sexes were sexually mature (Bailey 1972). Activity of burbot increases in autumn as energy reserves are concentrated on the growth and development of gonads for the winter spawning season (Kirillov 1988). Maturation of the gonads in both sexes occurs at about four months after the fall peak in nutritional reserves (Bailey 1972; Kirillov 1988; Pulliainen and Korhonen 1990).

Burbot breed once per year in the winter, migrating to shallow water or to a smaller stream to spawn (Cohen et. al. 1990). Burbot move to spawning areas individually and males tend to arrive before females (Morrow 1980). Spawning occurs during the night when individuals form a globular mass, each fish pushing toward the center and releasing eggs or sperm (Cahn 1936; MacCrimmon 1959). Post spawning runs upstream have been observed, most likely for feeding (Cahn 1936; MacCrimmon 1959; Morrow 1980; Cohen et al. 1990). Burbot are broadcast spawners and provide no parental care. Parental investment in burbot is characterized by an increased metabolic activity level and food consumption rates in the fall in order to contribute to the growth and maturation of gonads in both male and females over a four month period preceeding spawning events (Kirrilov 1988; Pulliainen and Kohonen 1990). It has been suggested that burbot may require one to two years to replenish their nurtritional reserves after each spawning event. (Kirillov 1988; Pulliainen and Korhonen 1990).

Distribution: Burbot are native to Alaska, Canada and the northern continental U.S., with their range extending as far south as Wyoming and northeastern Utah. Burbot have been widely introduced and populations are now established in Connecticut, Illinois, Indiana, New Jersey, Ohio and Pennsylvania (Fuller 2008). Burbot have been found in Flaming Gorge Reservoir as far south into Utah as Linwood Bay and Antelope Flat. Biologists expect the burbot to move into the reservoir's array of canyons and as far south as the Flaming Gorge Dam (Pers. Comm. Roger Schneidervin. 2008. Aquatic Program Manager, Northeastern Region, Utah Division of Wildlife Resources).

Pathways of Introduction: Burbot are a non-native invasive species probably introduced by sportsman into Flaming Gorge Reservoir (Pers. Comm. Roger Schneidervin. 2008. Aquatic Program Manager, Northeastern Region, Utah Division of Wildlife Resources).

Management Considerations: The only management tactic that has been tried on Flaming Gorge Reservoir, so far, is angling. Burbot have no limit and have a must kill or illegal to release law. Burbot have been caught over the winter months through the ice in large quanities. Because this is a newly introduced species into Flaming Gorge Reservior, Utah Division of Wildlife Resources, in cooperation with Utah State University, will begin a graduate study in 2008 to closer study the impacts of bubot on this ecosystem. It will be difficult to convince Utah's anglers that burbot is an AIS, since they grow large

and taste good; regardless, they will likely impact desired game fish in Flaming Gorge Reservoir (Pers. Comm. Roger Schneidervin. 2008. Aquatic Program Manager, Northeastern Region, Utah Division of Wildlife Resources).

Literature Cited:

Bailey, M.M. 1972. Age, growth, reproduction, and food of the burbot, *Lota lota* (Linnaeus), in Southwestern Lake Superior. Transactions of the American Fisheries Society 101(4): 667-674.

Billard, R. 1997. Les poissons d'eau douce des rivières de France: identification, inventaire et répartition des 83 espèces. Delachaux & Niestlé, Lausanne, Switzerland.

Bjorn, E. 1940. Preliminary Observations and Experimental Study of the ling, *Lota maculosa* (LeSueur), in Wyoming. Transactions of the American Fisheries Society 69:192-196.

Cahn, A. 1936. Observations on the breeding of lawyer, *Lota maculosa*. Copeia 3:163-165.

Cohen, D., T. Inada, T. Iwamoto, and N. Scialabba. 1990. Gadiform fishes of the world : order Gadiformes, an annotated and illustrated catalogue. Food and Agriculture Organization of the United Nations, Rome.

Fuller, P. 2008. *Lota lota*. USGS Nonindigenous Aquatic Species Database, Available: nas.er.usgs.gov/queries/FactSheet.asp?speciesID=698.(August 27, 2008).

Ghan, D., and W. Sprules. 1993. Diet and prey selection in young burbot. Journal of Fish Biology 42:47-64.

Kirillov, A. 1988. Burbot of Vilyusk Resevoir. Journal of Ichthyology 28(2):49-55.

MacCrimmon, H. 1959. Observations on spawning of burbot in Lake Simcoe, Ontario. Journal of Wildlife Management 23(4): 447-449.

Morrow, J. 1980. The Freshwater Fishes of Alaska. Alaska Northwest Publishing Company, Anchorage.

Pulliainen, E., K. Korhonen. 1990. Seasonal changes in condition indices in adult mature and non-maturing burbot, *Lota lota* (L.), in the north-eastern Bothnian Bay, Northern Finland. Journal of Fish Biology 36(2): 251-259.

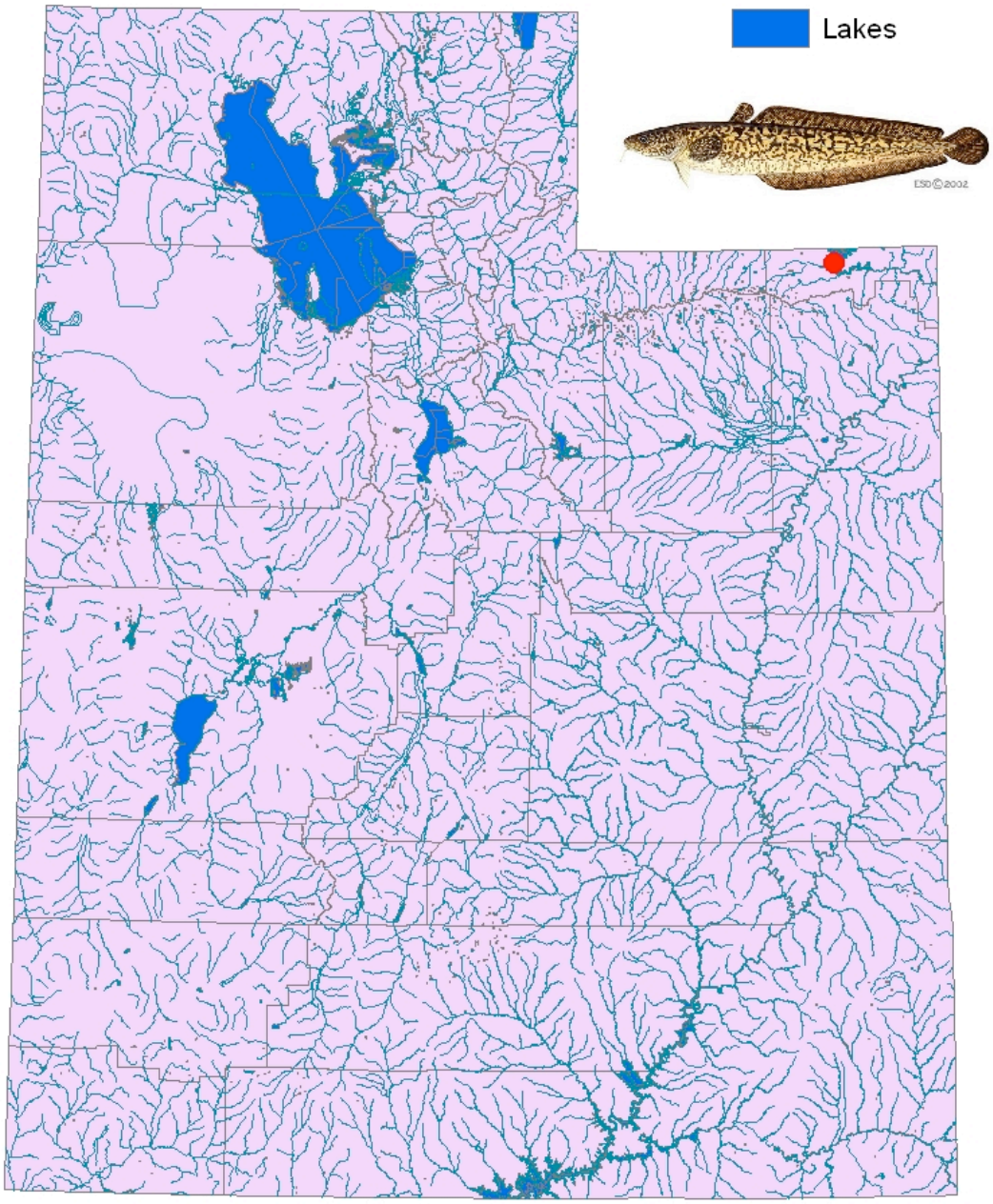
Riede, K. 2004. Global register of migratory species: from global to regional scales. Federal Agency for Nature Conservation, Final report of the R&D Projekt 808 05 081, Bonn, Germany.

Scott, W., E. Crossman. 1973. Freshwater fishes of Canada. Bulletin of the Fisheries Research Board Canada 184:1-966.

Tolanen, A., J. Kjellmann, and J. Lappalainen. 1999. Diet overlap between burbot and whitefish in a subarctic Lake. Anale. Zoologici Fennici 36:205-214.

Burbot

Lota lota



Gizzard Shad *Dorosoma cepedianum*

Ecology: *D. cepedianum* is black and silvery blue in color,, with a white abdomen and reach an average total length of approximately 225-350 mm (Miller 1960). Scales are large, cycloid, and deciduous. Lateral line is not present.

The gizzard shad is common in lakes, oxbows, impoundments, sloughs and large rivers with low gradients (Trautman 1981; Etnier and Starnes 1993), but reaches greatest abundance in waters where fertility and productivity are high (Robison and Buchanan 1988; Pflieger 1997). Gizzard shad avoid high gradient streams and rivers in the mountains and rivers without large, permanent pools, but can tolerate moderately turbid and, occasionally, even brackish or salt waters (Trautman 1981; Robison and Buchanan 1988; Pflieger 1997). The gizzard shad prefers living in open water, at or near the surface (Becker 1983; Harlan et al. 1987).

The gizzard shad spawns in shallow backwaters or near the shore. Gizzard shad spawn at night, spring through summer, eggs hatch in about 2-4 days. Eggs randomly scatter and adhere to plants, rocks or firm substrate. Spawning peak occurs from 19-22° Celsius. Most spawn at age II during a six-week spawning period. Fecundity ranges from 22,000 to 350,000 eggs. Buoyant larvae become plankton. They reach sexual maturity usually in 2-3 years (Robison and Buchanan 1988). Life span is generally about 4-6 years with few surviving beyond age class III (Sublette et al. 1990).

Typically found traveling in schools, juveniles are nonvisual planktivores, most commonly utilizing zooplankton and phytoplankton in the diet. Adults are primarily bottom filter-feeding detritivores; eating large quantities of organisms attached to underwater surfaces, especially from littoral areas. Gizzard shad also feed on phytoplankton in open water (Sublette et al. 1990).

Distribution: Gizzard shad were unknown in Utah until 2002, when six individuals were documented in the San Juan arm of Lake Powell. They are currently found throughout Lake Powell. Since their initial discovery, Gizzard shad have spread upstream into the Colorado River and Green River systems (Pers. Comm. Paul Birdsey. 2008. Southeaster Region Aquatic Program Manager, Utah Division of Wildlife Resources). Utah Division of Wildlife Resources introduced Gizzard Shad as a forage fish into Willard Bay Reservoir in 1990 (Pers. Comm. Craig Schaugaard. 2008. Northern Region Aquatic Program Manager, Utah Division of Wildlife Resources). This area drains immediately into the Willard Bay arm of the Great Salt Lake, so downstream escape is not considered a problem, due to the lake's high salinity.

In 2006, sampling of the Green River was conducted to evaluate the response of small- bodied native fish to non-native predator removal. Seining was conducted in suitable low-flow and backwater habitats. Of potential significance in 2006 were the observation of small, non-native gizzard shad in backwaters, a decrease in the number of native species, and the number of individuals within each native species. Most native Colorado River fish such as: Colorado River Pike minnow (*Ptychocheilus lucius*), Bonnytail Chub (*Gila elegans*), Humpback Chub (*Gila cypha*) and Razorback Sucker (*Xyrauchen texanus*) are protected under the Endangered Species Act and the others: Flannelmouth Sucker (*Catostomus latipinnis*), Bluehead Sucker (*Catostomus discobolus*) and Roundtail Chub (*Gila robusta*) are protected as state of Utah sensitive species. Not all gizzard shad were measured; however, of those that were (n=8), their mean length was 39.75 mm. Lengths of these fish ranged from 36mm to 41mm. Given that fish of such small lengths were found in several backwaters from river mile 281 to 215 (nine total backwaters), the

researchers are convinced that this species has begun to reproduce in the middle Green River (Pers. Comm. Krissy Wilson. 2008. Native Aquatic Species Program Coordinator, Utah Division of Wildlife Resources).

Pathways of introduction: The method of introduction of gizzard shad into Utah is unknown. It is likely that they came from illegal fish stocking by individuals under the assumption that they would provide good forage for Lake Powell sport fish (Pers. Comm. Krissy Wilson. 2008. Native Aquatic Species Program Coordinator, Utah Division of Wildlife Resources). Also, they may have been accidentally introduced via fish transport operations from other states in which they are common (Pers. Comm. Tim Miles. 2008. Hatchery Program Coordinator, Utah Division of Wildlife Resources). It has been reported by U.S. Fish and Wildlife that gizzard shad were accidentally introduced into Morgan Lake near Shiprock, NM with a shipment of largemouth bass in 1998 (UDWR 2006). The bass came from Inks Dam National Fish Hatchery in south-central Texas in the Rio Colorado drainage where gizzard shad are abundant in the surface water used at the hatchery. Later loads of bass transported to Morgan Lake from the hatchery, besides largemouth bass (*Micropterus salmoides*), were found to have several different species (e.g. Guadalupe bass (*Micropterus treculii*), logperch (*Percina caprodes*), gizzard shad, white bass (*Morone chrysops*), bluegill (*Lepomis macrochirus*), and dollar sunfish (*Lepomis marginatus*)).

Management considerations: A review by DeVries and Stein (1990) suggests that gizzard shad might not be an ideal forage fish. Gizzard shad can consistently produce large numbers of offspring from few adults (Miller 1960; Pierce 1977), and their larvae may compete with other fishes for zooplankton (DeVries and Stein 1992). Furthermore, because gizzard shad grow quickly (Bodola 1966), they often reach a size refuge from most predators by the end of their first year (Adams and DeAngelis 1987; Johnson et al. 1988). Impressive larval production, coupled with fast growth, was shown to limit predator consumption to a maximum of 30% of gizzard shad production in Ohio reservoirs (Johnson et al. 1988). Most importantly, however, gizzard shad are opportunistic omnivores, feeding on zooplankton as larvae, but capable of switching to phytoplankton or detritus as juveniles and adults (Miller 1960; Bodola 1966; Pierce 1977). As a result, gizzard shad can drive zooplankton to extinction, yet still survive and grow to adulthood. Gizzard shad also spawn before many sport fishes (e.g., bluegill *Lepomis macrochirus*), thus their larvae may deplete zooplankton resources to the extent that sport-fish larvae may face unfavorable conditions for growth and survival.

In 2006, threadfin shad (*Dorosoma petenense*) populations, a forage fish in Lake Powell, decreased as a response to heavy predation from large numbers of adult sport fish, while the adult gizzard shad population continued to grow. Due to the suitable habitat available and the uncontrolled population expansion of gizzard shad in Lake Powell, this species will negatively affect the management and planning of recreational sport fishing opportunities in Lake Powell. The competitive nature of gizzard shad will likely pose an additional threat to the endangered and sensitive fish species of the Colorado River (Pers. Comm. Paul Birdsey. 2008. Southeastern Region Aquatic Program Manager, Utah Division of Wildlife Resources).

Literature Cited:

Adams, S. M., and D. L. DeAngelis. 1987. Indirect effects of early bass-shad interactions on predator population structure and food web dynamics. Pages 103-117 *in* W. C. Kerfoot and A. Sih, editors. Predation: direct and indirect impacts on aquatic communities. University Press of New England, Hanover, New Hampshire.

Becker, G.C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison.
Bodola, A. 1966. Life history of the gizzard shad, *Dorosoma cepedianum* (LeSueur), in western Lake Erie. U.S. Fish and Wildlife Service Fishery Bulletin 65:391-425.
DeVries, D. R., and R. A. Stein. 1990. Manipulating shad to enhance sport fisheries in North America: an assessment. North American Journal of Fisheries Management 10:209-223.
DeVries, D. R., and R. A. Stein. 1992. Complex interactions between fish and zooplankton: quantifying the role of an open-water planktivore. Canadian Journal of Fisheries and Aquatic Sciences 49:1216-1227.
Etnier, D.A., and W.E. Starnes. 1993. The fishes of Tennessee. University of Tennessee Press, Knoxville.
Harlan, J.R., E.B. Speaker, and J. Mayhew. 1987. Iowa fish and fishing. Iowa Conservation Commission, Des Moines.
Johnson, B. M., R. A. Stein, and R. F. Carline. 1988. Use of a quadrat rotenone technique and bioenergetics modeling to evaluate prey availability to stocked piscivores. Transactions of the American Fisheries Society 117:127-141.
Miller, R. R. 1960. Systematics and biology of the gizzard shad (Dorosoma cepedianum) and related fishes. U.S. Fish and Wildlife Service Fishery Bulletin 173:371-392.
Pflieger, W.L. 1997. The fishes of Missouri. Missouri Department of Conservation, Jefferson City.
Pierce, R. J. 1977. Life history and ecological energetics of the gizzard shad (*Dorosoma cepedianum*) in Acton Lake, Ohio. Doctoral dissertation. Miami University, Oxford, Ohio.
Robison, H.W., and T.M. Buchanan. 1988. Fishes of Arkansas. University of Arkansas Press, Fayetteville.
Sublette, J. E., M. D Hatch, and M. Sublette. 1990. The fishes of New Mexico. University New Mexico Press, Albuquerque.
Trautman, M.B. 1981. The fishes of Ohio. Revised Edition. Ohio State University Press in collaboration with the Ohio Sea Grant Program Center for Lake Erie Area Research, Columbus, Ohio.
(UDWR) Utah Division of Wildlife Resources. 2006. Gizzard shad found in Lake Powell. Available: http://wildlife.utah.gov/news/02-08/shad.php. (September 2008).

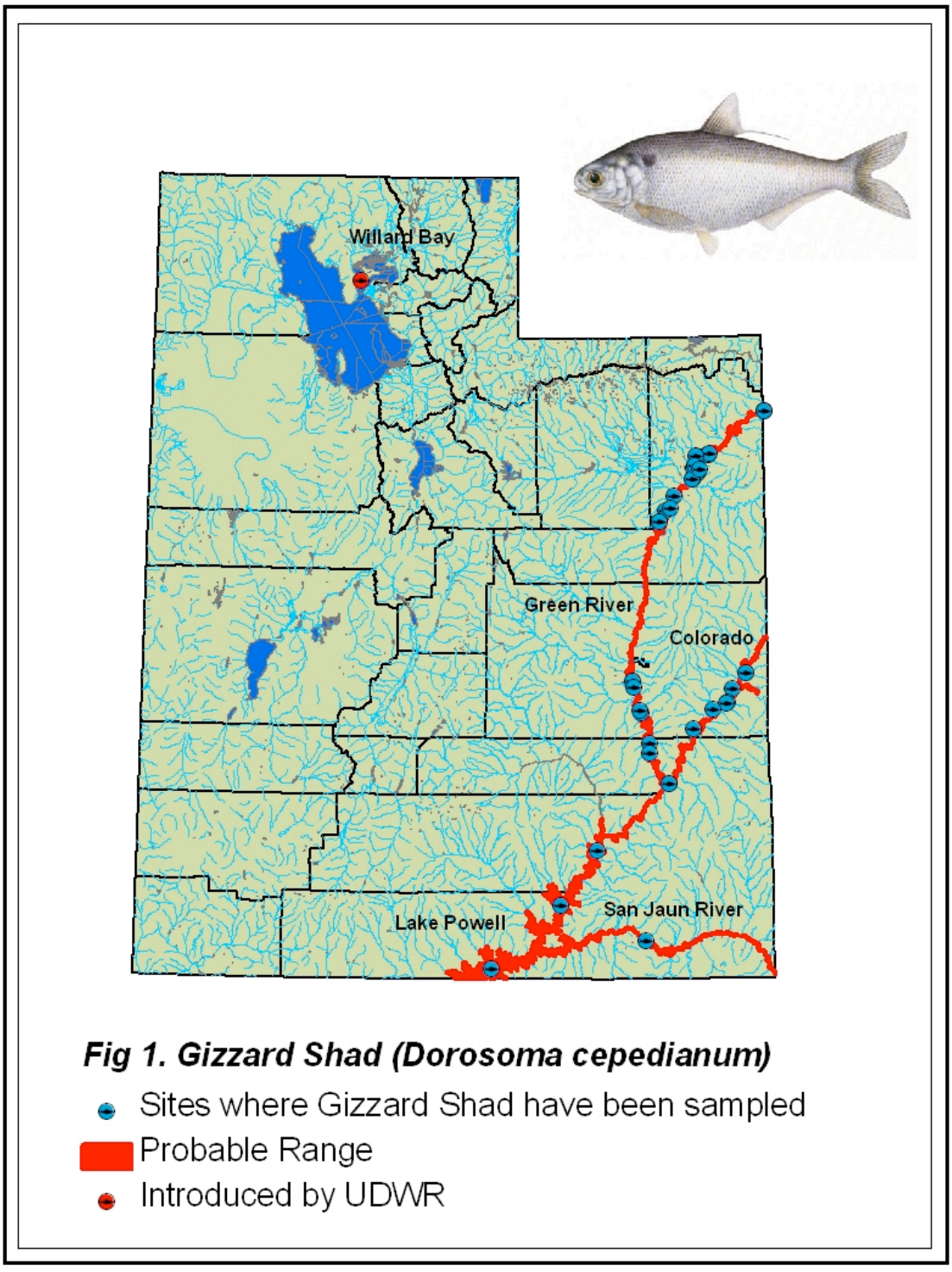


Fig 1. Gizzard Shad (Dorosoma cepedianum)

- Sites where Gizzard Shad have been sampled
- Probable Range
- Introduced by UDWR

Western Mosquitofish *Gambusia affinis*

Ecology: Mosquitofish are small, 3 to7cm in length, poeceliids with short bodies, flat heads and rounded tails. Mosquitofish live in fresh and brackish water in vegetated ponds and lakes, backwaters and quiet pools of streams. They are able to survive in waters with little oxygen, in high salinities (including twice that of sea water) and in temperatures up to 42°C (McCullough, 1998). They have upturned mouths for surface feeding on zooplankton and other invertebrate prey (Rauchenberger 1989). This species is well known for its high feeding capacity and adults will even feed on their young opportunistically (Benoit et al. 2000). Chips (2004) observed maximum consumption rates of 42 to 167% of their body weight per day. Mosquitofish have internal fertilization and are ovoviviparous (Meffe 1986). Females can have four to five broods annually with brood sizes up to 315 young (Krumholz 1948).

Mosquitofish were originally introduced and spread as a way to reduce mosquito populations and mosquito-borne diseases. Recent research, however, questions the efficiency of this species as a mosquito control agent and suggests that negative impacts on native species may outweigh the benefits from possible mosquito control (Courtenay and Meffe 1989). Because of their aggressive and predatory behavior, mosquitofish may negatively affect populations of small fish through predation and competition (Courtenay and Meffe 1989). They may also benefit mosquitoes by decreasing competitive and predation pressure from native zooplankton and predatory invertebrates (Blaustein and Karban 1990). Introduced mosquitofish can displace native fish species considered more efficient mosquito control agents (Courtenay and Meffe 1989).

Introduced mosquitofish have contributed to the elimination or decline of populations of federally endangered and threatened fish species in the western U.S. and are responsible for the elimination of the least chub *Iotichthys phlegethontis* in several areas of Utah (Mills et al. 2004). This species is also considered partially responsible for the decline of several amphibian species in the western U.S. (Gamradt and Kats 1996; Goodsell and Kats 1999).

Distribution: The mosquitofish is native to the south-central United States and Mexico (Rauchenberger 1989). Though, through extensive introductions, it now has a pan-global distribution. Mosquitofish have been introduced into ponds throughout Utah, however, colder temperatures in much of the state limited full establishment. Mosquitofish in Utah have been most successful in spring fed pools where relatively constant water sources improve survival. Breeding populations are established in warm springs and littoral zones of ponds in the Bonneville Basin (Sigler and Sigler1996).

Pathway of Introduction: In the United States the first known introductions of mosquitofish, outside of their native range, took place in the early 1900's as mosquito control agents (Krumholz 1948). Mosquitofish were commonly and widely introduced during the following decades. Mosquitofish were intentionally introduced into Salt Lake City, Utah as a biocontrol for mosquitoes in 1932 (Reese 1934). Mosquito abatement programs in Utah continue to utilize western mosquitofish as a biological control (Billman et al. 2007).

Management Considerations: Rotenone can be used to remove fish from small areas of permanent water. Rotenone, however, is indiscriminate, so non-target species need to be removed prior to its application and prevention of reinvasion from tributaries should be considered (Mills et al. 2004).

Least chub have been shown to consume immature mosquitoes even in the presence of other prey and unlike mosquitofish; least chub are able to survive drought conditions and harsh winters (Billman et al. 2007). The native least chub is being considered as an alternative form of mosquito control to mosquitofish (Pers. Comm. Krissy Wilson. 2008. Native Aquatic Species Program Coordinator, Utah Division of Wildlife Resources). The use of least chub as an alternative biocontrol to mosquitofish would minimize negative impacts on other native species and greatly enlarge the distribution of least chub.

Literature Cited:

Benoît, H. P., Post, J. R., and Barbet, A. D. 2000. Recruitment dynamics and size structure in experimental populations of the mosquitofish, *Gambusia affinis*. Copeia 1:216-221.

Billman, E., Wagner, E. & Arndt, R., 2007. A comparison of mosquito consumption and prey selection between least chub (*Iotichthys phlegethontis*) and western mosquitofish (G*ambusia affinis*). Western North American Naturalist 67(1):71-78.

Blaustein, L. and R. Karban. 1990. Indirect effects of the mosquitofish *Gambusia affinis* on the mosquito *Culex tarsalis.* Limnology and Oceanography 35(3):767-771.

Chipps, S. R., and D. H. Wahl. 2004. Development and evaluation of a western mosquitofish bioenergetics model. Transactions of the American Fisheries Society 133(5):1150-1162.

Courtenay, W. R., Jr., and G. K. Meffe. 1989. Small fishes in strange places: a review of introduced poeciliids. Pages 319-331*in* G. K. Meffe and F. F. Snelson Jr., editors. Ecology and evolution of livebearing fishes (Poeciliidae). Prentice Hall, Englewood Cliffs, New Jersey.

Goodsell, J.A. and L.B. Kats. 1999. Effect of introduced mosquitofish on Pacific treefrogs and the role of alternate prey. Conservation Biology 13(4): 921-924.

Gramradt, S.C. and L.B. Kats. 1996. Effect of introduced crayfish and mosquitofish on California newts. Conservation Biology 10(4): 1155-1162.

Kurmholz, L. A. 1948. Reproduction in the western mosquitofish, *Gambusia affinis affinis* (Baird and Girard), and its use in mosquito control. Ecological Monographs 18:1-43.

Meffe, G.K., 1986. Cannibalism, food availability, and reproduction in mosquitofish: a critique. The American Naturalist 127(6):897-901.

Mills, M., R. Rader, and M. Belk 2004. Complex interactions between native and invasive fish. Oecologia 141:713-721.

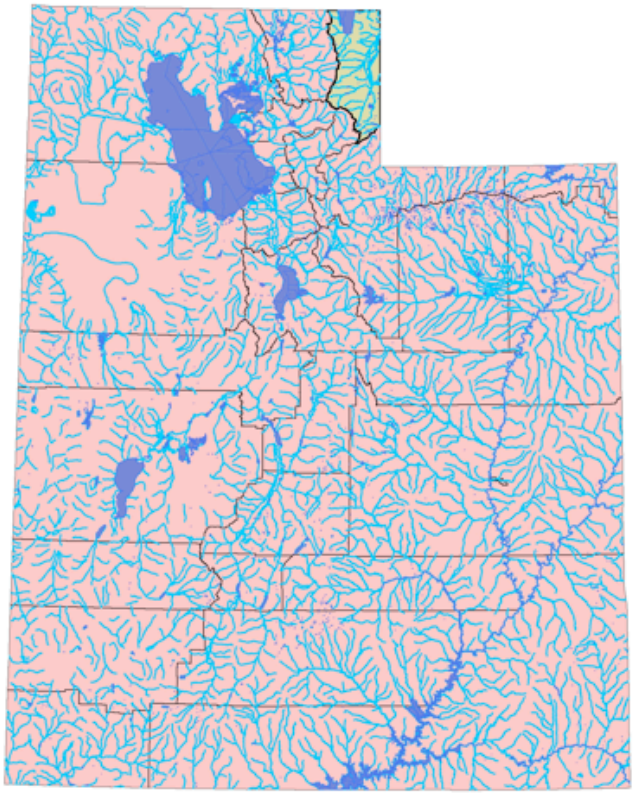
Myers, G. S. 1965. *Gambusia*, the fish destroyer. Australian Zoologist 13(2): 102.

Rauchenberger, M. 1989. Systematics and biogeography of the genus Gambusia (Cyprinodontiformes: Poecilidae). American Museum Novitates 2951:1-74.

Reese, D.M. 1934. Notes on mosquito fish in Utah, *Gambusia affinis* (Baird and Girard). Copeia 1945(4):1-236.
Sigler, W.F. and J.W. Sigler. 1996. Fishes of Utah: a natural history. University of Utah Press, Salt Lake City, Utah.

Mosquitofish

Major Waterways
Counties mosquito fish is present.



Slaboch, R.
Fishbase Online

AMPHIBIANS

Green Frog *Rana clamitans*

Ecology: The green frog is large with adults ranging in size from two to four inches in length. Life span in the wild is unknown, but captive frogs have been known to live up to ten years. Males and females are phenotypically different. Males have a tympanum that is larger than their eyes and a yellow throat. Females have a tympanum that is the same size as their eyes and a white throat. Both sexes have prominent dorsolateral ridges and dark, transverse bands on their legs and webbed toes. The first fingers do not extend past the second. There are various color phases including bronze, brown, light green and in very rare cases, blue (Gillilland 2000).

Green frogs are both diurnal and nocturnal, living in and around shallow water. They will enter dormancy during colder months. Green Frogs are a solitary species except during breeding season when they congregate at breeding locations (Wikipedia 2008). Males guard their breeding territory, which is approximately one to six meters in diameter, and sing to attract females (Gillilland 2000). These frogs also have excellent vision, used to locate prey. Green frogs are opportunistic carnivores and employ the sit-and-wait hunting tactic to capture their prey, which includes insects, worms and fish (Barry and Lockard 2003; Gillilland 2000).

Breeding takes place in late spring and summer (Stebbins 2003), and lasts between one to three months. Each female produces 1,000 – 7,000 eggs (Wikipedia 2008). These eggs are attached to emergent aquatic vegetation or they float on the surface of the water. Gestation takes three to five days. After hatching the tadpoles usually overwinter during their first year and then transform the following summer (Minnesota Department of Natural Resources 2008).

Distribution: Green frogs are native to the eastern United States (Hammerson 2004; Stebbins 2003). They are currently found along the northern Wasatch front in the following Utah counties: Rich, Morgan and Summit (Pers. Comm. 2008. Craig Schaugaard, Northern Region Aquatic Manager, Utah Division of Wildlife Resources); along with Wasatch and Utah (Pers. Comm. 2008. Don Willey, Central Region Aquatic Manager, Utah Division of Wildlife Resources; Utah Division of Wildlife Resources 2005).

Pathways of Introduction: While native to the eastern United States, they were likely introduced to the West, including Utah, through the pet trade. As their populations grow, they will continue to spread throughout Utah and the West (Pers. Comm. 2008. Krissy Wilson, Native Aquatics Coordinator, Utah Division of Wildlife Resources).

Management Concerns: The green frog poses a threat to native species. They compete for food and other resources with native amphibians, including the threatened Boreal toad (*Bufo boreas boreas)*. Natural predators to these frogs include native birds and snakes. Currently, there are no management efforts in Utah that specifically target the green frog

(Pers. Comm. 2008. Krissy Wilson, Native Aquatics Coordinator, Utah Division of Wildlife Resources).

Literature Cited:

Barry, P. and V. Lockard. 2003. Canku Ota: An Online Newsletter Celebrating Native America. Available: http://www.turtletrack.org/Issues03/Co05172003/CO_05172003_Story_Rabbits.htm. (February 2008).

Gillilland, M. 2000. "*Rana clamitans*" Animal Diversity Web. Available: http://animaldiversity.ummz.umich.edu/site/accounts/information/Rana_clamitans.html. (February 2008).

Hammerson, G. 2004. *Rana clamitans*. 2007 IUCN Red List of Threatened Species. Available: http://www.iucnredlist.org/details/58578 (August 2008).

Minnesota Department of Natural Resources. 2008. Green Frog – *Rana clamitans*. Available: www.dnr.state.mn.us/reptiles_amphibians/frogs_toads/truefrogs/green.html. (September 2008).

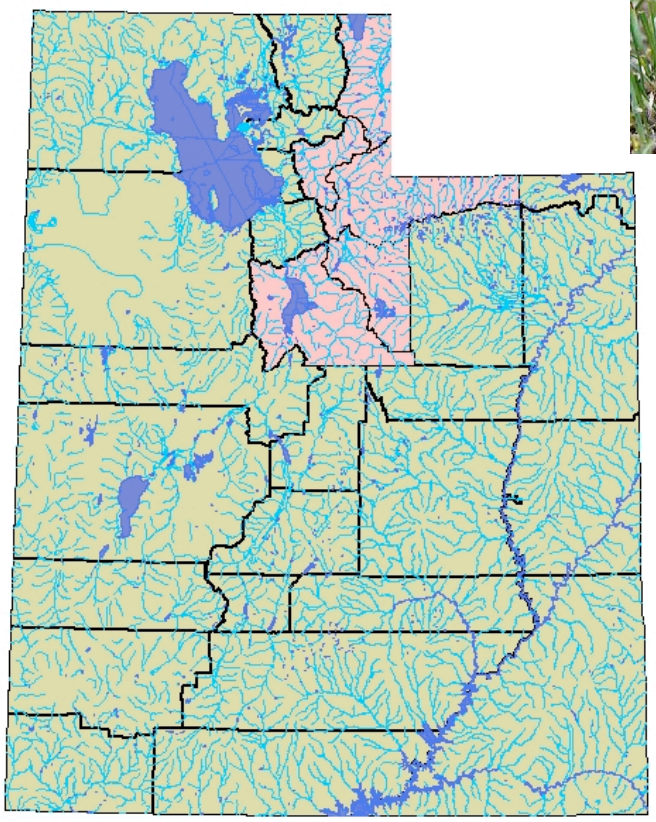
Stebbins, R. C., 2003. A field guide to western reptiles and amphibians. Houghton Mifflin Company, Boston, Massachusetts.

Utah Division of Wildlife Resources. 2005. Utah Conservation Data Center: Green Frog. Available: http://dwrcdc.nr.utah.gov/rsgis2/Search/Display.asp?FlNm=ranaclam. (January 2008).

Wikipedia. 2008. Green frog. Available: http://en.wikipedia.org/wiki/Green_frog (February 2008).

Green Frog

Major Waterways
Counties with Green Frog



North American Bullfrog *Rana catesbeiana*

Ecology: North American bullfrogs are the largest true frog found in North America, weighing up to 0.5 kg and reaching 203 mm in length. Typical lengths range from 90 to 152 mm. Color varies from brownish to shades of green, often with spots or blotches of a darker color about the back. The hind feet are fully webbed. The sex of an adult bullfrog can be easily determined by examining the size of the tympanum (the external ear of the frog) relative to that of the eye: in males the tympanum is much larger than the eye; in females the tympanum is equal to or smaller than the eye. Also, during the breeding season the throat of the male bullfrog is yellow, whereas the female's is white (Bruening 2002). North American bullfrogs are only native to the Nearctic region. They are found from Nova Scotia to central Florida, from the East coast to Wisconsin, and across the Great Plains to the Rockies. The natural western limits of this species are now confused due to their introduction into places as far west as California and Mexico. It is known that bullfrogs were introduced to areas of California and Colorado in the early 1900's. The species has also been introduced (accidentally or on purpose) into southern Europe, South America and Asia (Bruening 2002).

Breeding takes place in May to July in the north, and from February to October in the south; Utah would be considered part of its northern breeding range. Fertilization is external, with the females depositing as many as 20,000 eggs in a foamy film in quiet, protected waters. Fertilization is usually, but not always, by one male. Tadpoles emerge about four days after fertilization. These tadpoles may remain in the tadpole stage for almost 3 years before transforming into frogs. Adults reach sexual maturity after 3 to 5 years. The average bullfrog lives seven to nine years in the wild. The record lifespan of an animal in captivity is 16 years (Bruening 2002).

North American bullfrogs prefer warm weather and will hibernate during cold weather. A bullfrog may bury itself in mud and construct a small cave-like structure for the winter. Bullfrogs are active both during the day and at night (Govindarajulu 2000).
Bullfrogs are very aggressive predators. They eat snakes, worms, insects, mice, crustaceans, frogs, tadpoles, and aquatic eggs of fish, frogs, insects, or salamanders. There have also been a few cases reported of bullfrogs eating bats, and turtles. They are also cannibalistic and will not hesitate to eat their own kind. Bullfrog tadpoles mostly graze on aquatic plants (Bruening 2002; Hedrick 2008).

Humans hunt bullfrogs, since their legs are considered a tasty meal, but there is a limited hunting season in most states. In Utah a fishing license is required to hunt bullfrog, but there is no season and no limit. Bullfrogs are also eaten by a wide variety of other animals including: herons, such as great blue herons and great egrets; turtles; water snakes; raccoons; and belted kingfishers (Bruening 2002).

Distribution: Bullfrogs were introduced into the west (California and Colorado) in the early 1900's and since then they have been introduced into Southern Europe, South America and Asia (Bruening 2002). It is unknown when they first arrived in Utah, but a breeding population has existed along the Colorado River, in the Moab marsh, since the early 1970s (Pers. Comm. Larry Dalton. 2008. Aquatic Invasive Species Coordinator,

Utah Division of Wildlife Resources). Today, bullfrog populations persist in many areas of Utah (Pers. Comm. Krissy Wilson. 2008. Native Aquatic Species Program Coordinator, Utah Division of Wildlife Resources).

Pathways to Introduction: In Utah, especially along the Wasatch Front, plant nurseries were known to give away bullfrogs with the purchase of backyard water features. Also, teachers were receiving bullfrog tadpoles in educational activity kits, and then allowing children to take the frogs home, when the lesson was completed. The bullfrogs were then released into the wild, once the children and their families tired of the hobby (Pers. Comm. Diana Vos. 2008. Project WILD Coordinator, Utah Division of Wildlife Resources). Bullfrogs have also been accidentally introduced during trout stocking, through the aquarium trade, and for sport and pest control (USDA 2008).

Management Considerations: Strategies to control negative impacts from bullfrogs vary from state to state. A recommended technique for control in stock water ponds is draining them entirely while at the same time shooting adults as they attempt to escape (Doubledee et al. 2003). Arizona has employed this technique in numerous isolated areas around the state to benefit various sport fisheries (Pers. Comm. Trina Hedrick. 2008. Utah Division of Wildlife Resources Northeastern Region Aquatic Native Species Biologist). Colorado allows unlimited statewide harvest of bullfrogs, which can legally be taken by archery, gig, dip net, or by hand. Members of the public still continue to move bullfrogs around in British Columbia, so they have implemented an extensive public education program to increase people's knowledge of the harm that bullfrogs do to native ecosystems. Govindarajulu (2004) stated, in his review of bullfrog populations in British Columbia, that complete eradication is only feasible in small, isolated areas. However, he does recommend culling metamorphs in the early fall as a method to control their populations vs. removal of adults, which tends to increase populations due to decreased cannibalism (Govindarajulu et al. 2005).

Likely, filtering off metamorphs and physically killing adults bullfrogs is the only method for control during a translocation of fish stocks.

Biologists with the Utah Division of Wildlife Resources have worked with nurseries to discontinue giving away bullfrogs. Utah Division of Wildlife Resources has also contacted educational companies distributing frogs in educational kits. Educators in Utah will no longer receive bullfrogs if they order from these companies; however, educators in neighboring states can still receive frogs with their order (Pers. Comm. Trina Hedrick. 2008. Utah Division of Wildlife Resources Northeastern Region Aquatic Native Species Biologist; Pers. Comm. Diana Vos. 2008. Project WILD Coordinator, Utah Division of Wildlife Resources).

Literature Cited:

Doubledee, R.A., Muller, E.B. and Nisbet, R.M. 2003. Bullfrogs, disturbance regimes, and the persistence of California red-legged frogs. Journal of Wildlife Management 67 (2): 424-438.

Bruening, S. 2002. *Rana catesbeiana*. Animal Diversity Web. Available: http://animaldiversity.ummz.umich.edu/site/accounts/information/Rana_catesbeiana.html. (September 23, 2008).

Govindarajulu, P. 2000. Survey of Bullfrogs *Rana catesbeiana* in British Columbia. Available: http://web.uvic.ca/bullfrogs/. (Spetember 1, 2000).

Govindarajulu, P. 2004. Introduced bullfrogs (*Rana catesbeiana*) in British Columbia: impacts on native Pacific treefrogs (*Hyla regilla*) and red-legged frogs (*Rana aurora*). Ph.D. thesis. University of Victoria, Victoria.

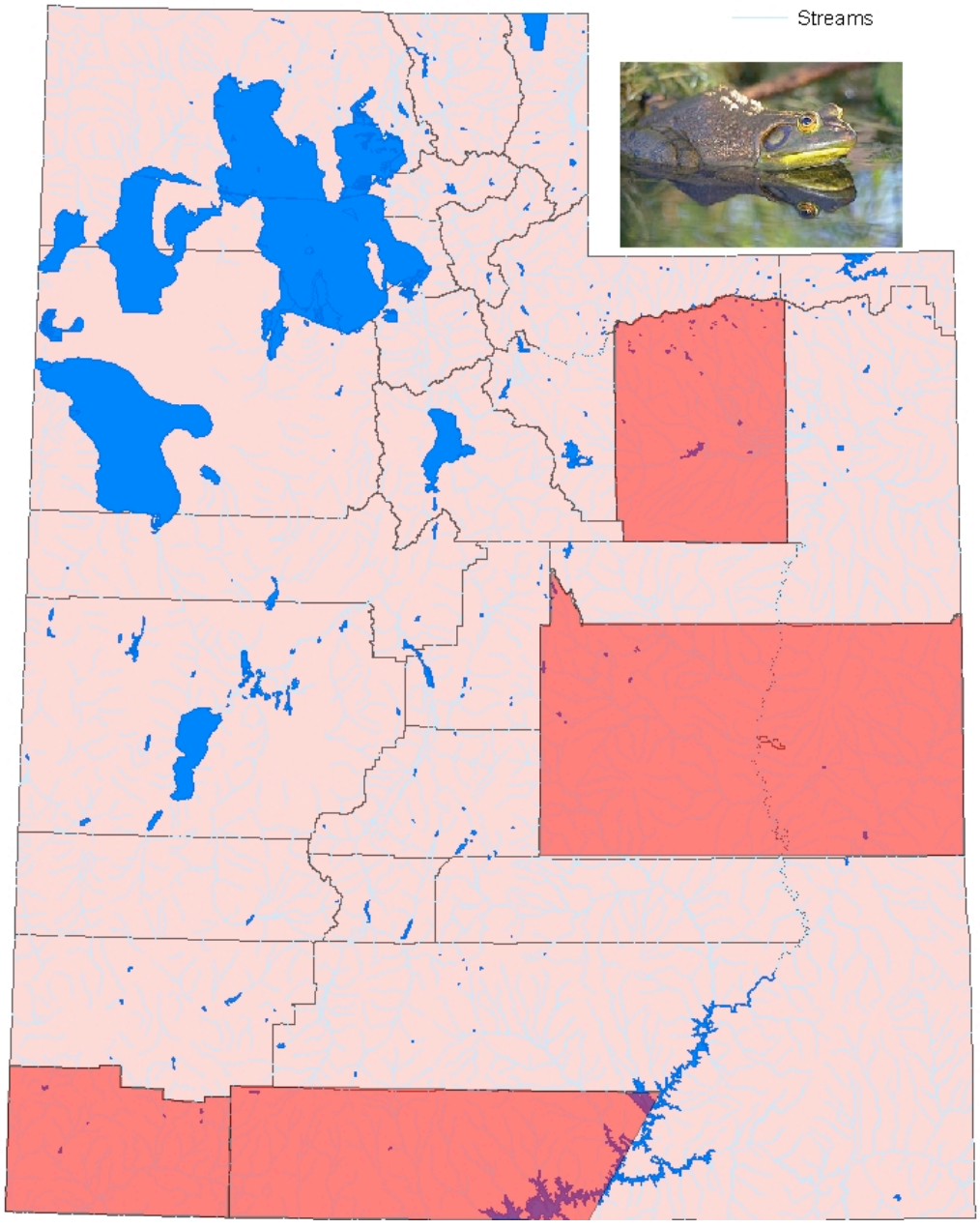
Govindarajulu, P., R. Altwegg, and B.R. Anholt. 2005. Matrix model investigation of invasive species control: bullfrogs on Vancouver Island. Ecological Applications, 15(6): 2161–2170.

United States Department of Agriculture, (USDA). 2008. National Invasive Species Information Center. Availlable: www.invasivespeciesinfo.gov/aquatics/bullfrog.shtml. (September 23, 2008).

American Bullfrog

(RANA CATESBEIANA)

Current Distribution



Plains Leopard Frog *Rana blairi*

Ecology: The plains leopard frog is about 2.8 to 3.9 inches long. *R. Blairi* are brown or green, and have two or three irregular rows of dark spots on their dorsum. This species is often confused with the northern leopard frog (*R. pipiens*), but *R. Blairi* can be distinguished by the presence of a light spot in the middle of the tympanum, a distinct light line along the upper jaw, and dorsolateral ridges that are interrupted just anterior to the groin and medially. *R. Blairi* is usually found in streams, reservoirs, ponds, ditches and other bodies of water, is active at warmer temperatures and has a critical thermal maximum body temperature of 37°C (Frost and Bagnara 1977; Conant and Collins 1991; Bartlett and Bartlett 1999).

Breeding occurs from February to October. Most move from overwintering sites to breeding sites in the spring. Males engage in sexual displays on the ground. Breeding rates, although variable, seem to peak following rains. Eggs are deposited in still, temporary or permanent shallow ponds or pools and are light gray in color. In Oklahoma, most clutches found contained 4,000-6,500 eggs, but some consisted of fewer than 200 eggs. Hatching occurs in 5 to 20 days and larvae transform about three months after eggs are deposited. When clutches are laid in late summer or early fall, larvae may overwinter and wait until the following spring to metamorphose. Tadpoles are tan and nondescript without distinct color patterns (Kuhrt 2000).

The plains leopard frog feeds on a variety of insects. They mostly use the sit and wait strategy. Once prey items have been sighted, they will stalk and seize them. The plains leopard frog will also actively forage either terrestrially or at the waters edge. They often forage away from water at night after summer rains (Kuhrt 2000).

Distribution: The plains leopard frog is found throughout the Great Plains of the United States, from Indiana west across the central and southern plains to South Dakota, south to Colorado, New Mexico, and Texas, with a separate population in Arizona (Clarkson and Rorabauch 1989; Conant and Collins 1991; Blackburn et al. 2001).

The plains leopard frog's current distribution in Utah is the Wahweap area of Lake Powell (Figure 1). It inhabits the lake margins and perennial zones of Wahweap Wash. It is also found in the Utah Division of Wildlife Resources' rearing ponds, for the endangered Bonytail Chub (*Gila elegans)* and other warm water game species, at the Wahweap State Fish Hatchery (Bradwisch 2008).

Pathways of Introduction: *R. Blairi* was most likely introduced as an aquatic "hitchhiker" within boats launching at Wahweap marina. Possibly, *R. Blairi* occurs in the Wahweap area of Lake Powell due to releases by boaters and anglers who hauled frog specimens from Arizona as bait or even aquarium releases, since they are routine visitors to the Wahweap area of Lake Powell (Bradwisch 2008; Gustaveson 2008).

Management Considerations: Management of frog populations is difficult because of their juxtaposition to native species in shared aquatic habitats. Current control efforts range from removal of breeding adults to removal of all life stages. Adult frogs can be

removed by trapping or hand captures. However, most mechanical methods are only successful in small areas, with limited populations (Pitt and Witmer 2006). Tadpoles can be destroyed by draining ponds or chemical treatment (Pitt and Sin 2004). Fencing may also be used to reduce spread of frogs from infested habitats (Pitt and Witmer 2006). The efficacy of previous efforts, as it relates to reduction in population growth or cost-effectiveness, has not been well evaluated (Govindarajulu et al. 2005).

Fish distribution from the Wahweap State Hatchery is currently permitted. However, all loads are filtered to capture and remove tadpoles and frogs, as the fish are loaded into haul trucks (Bradwisch 2008; Gustaveson 2008).

Literature Cited:

Bartlett, R. D., and P. P. Bartlett. 1999. A field guide to Texas reptiles and amphibians. Gulf Publishing Company, Houston.

Blackburn, L., P. Nanjappa, and M. J. Lannoo. 2001. An Atlas of the Distribution of U.S. Amphibians. Ball State University, Muncie, Indiana.

Bradwisch, C. 2008. Personal Communication. Wahweap State Fish Hatchery Superintendant, Utah Division of Wildlife Resources.

Clarkson, R. W., and J. C. Rorabauch. 1989. Status of leopard frogs (*Rana pipiens* complex: Ranidae) in Arizona and southeastern California. Southwestern Naturalist 34:531-538.

Conant, R. and J. T. Collins. 1991. A field guide to reptiles and amphibians: eastern and central North America. Third edition. Houghton Mifflin Co., Boston.

Frost, J. S., and J. T. Bagnara. 1977. Sympatry between RANA BLAIRI and the southern form of leopard frog in southeastern Arizona (Anura: Ranidae). Southwestern Naturalist 22:443-453.

Govindarajulu, P., R. Altwegg, and B. R. Anholt. 2005. Matrix model investigation of invasive species control: bullfrogs on Vancouver Island. Ecological Applications 15(6):2161-2170.

Gustaveson, W. 2008. Personal Communiocation. Principal Fishery Biologist, Lake Powell, Utah Division of Wildlife Resources. Page, Arizona

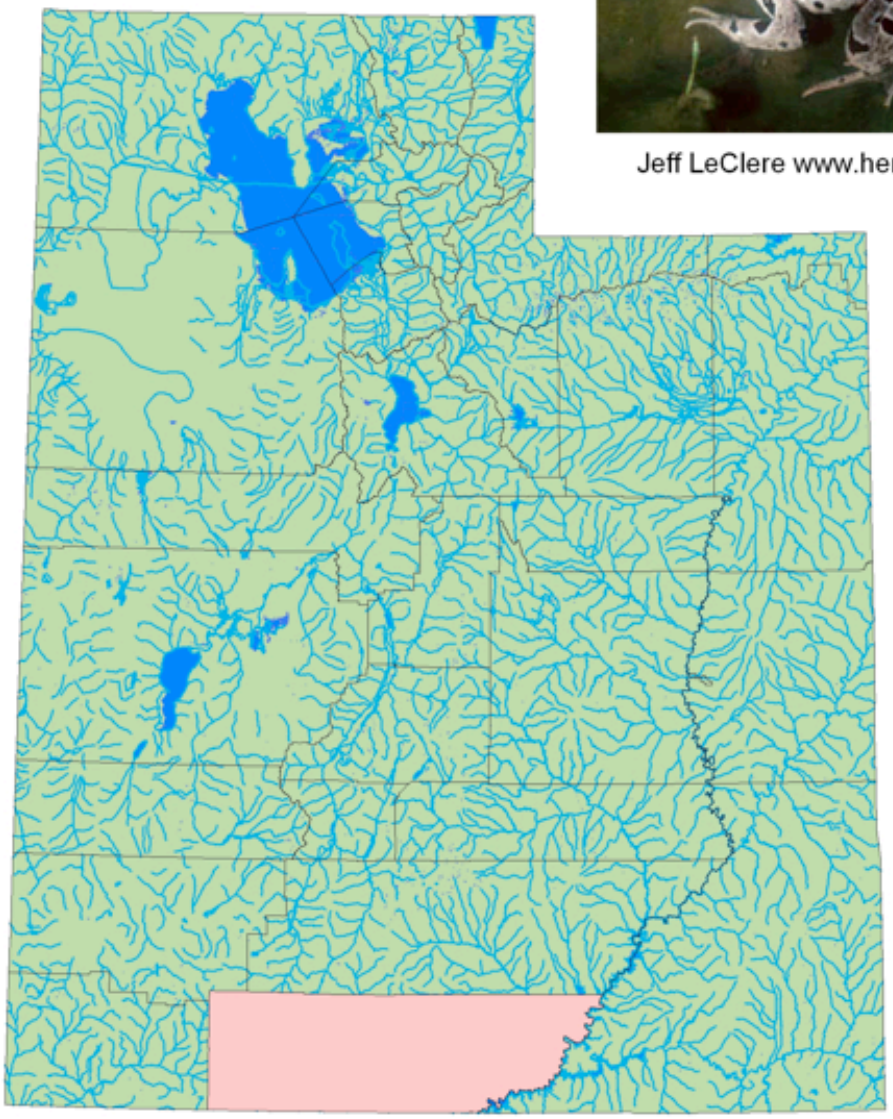
Kuhrt, T. 2000. *Rana blairi.* Animal Diversity Web. Available:animaldiversity.ummz.umich.edu/site/accounts/information/Rana_blairi.html. (September 2008).

Pitt, W. C., and G. W. Witmer. 2006. Invasive predators: a synthesis of the past, present, and future. Wildlife Damage Management, Internet Center for USDA National Wildlife Research Center – Staff Publications. University of Nebraska, Lincoln.

Pitt, W. C. and H. Sin. 2004. Dermal toxicity of citric ascid based pesticides to introduced Eleutherodactylus frogs in Hawaii. USDA, APHIS, WS, NWRC. Hilo, Hawaii.

Plains Leopard Frog- *Rana Blairi*

Jeff LeClere www.herpnet.net



Rio Grande Leopard Frog *Rana berlandieri*

Ecology: The Rio Grande leopard frog (*R. berlandieri*) is nocturnal and highly aquatic. Rio Grande leopard frogs are typically found on the edges of large slow-moving rivers, in agricultural ditches, drains, canals, and sumps (Platz et al. 1990; Jennings and Hayes 1994; Rorabaugh et al. 2002). *R. berlandieri* are pale green, olive, or a grayish brown with dorsal spots that are dark with a light rim, and dark reticulations on their thighs. *R. Berlandieri* also has prominent dorsolateral folds that turn inward in front of the groin. A light stripe also runs along the jaw but fades or completely disappears in front of the eye. Adults are 2.25 to 4.25 inches long from snout to vent (Hillis et al. 1983; Behler and King 1992; Stebbins 2003).

Hillis (1981) found that in central Texas *R. berlandieri* typically breeds in pools along flowing streams or rivers; though breeding can also occur in artificial ponds and tanks. In warm climates, the species may breed year around (Garrett and Barker 1987; Davidson 1996). In central Texas, the species breeds in spring and fall, but in areas of sympatry with other leopard frog species breeding occurs in fall and early winter (Hillis 1981; Platz 1972).

R. berlandieri feed on a variety of insects and invertebrates. In Texas, frog stomachs often contained small leopard frogs (Platz et al. 1990).

Distribution: *R. berlandieri* occur from central and western Texas and the Pecos River drainage in Eddy County, southeastern New Mexico, south along the Atlantic slope through at least southeastern Mexico (Platz 1991; Degenhardt et al. 1996; Conant and Collins 1998; Dixon 2000). *R. berlandieri* is not currently found in Utah. However, populations have been identified in the Lake Powell region in Arizona (Rorabaugh 2008) and pose an immediate risk of spread throughout Lake Powell.

Pathways of Introduction: *R. berlandieri* may arrive in Utah as an aquatic "hitchhiker" on boats launching at lakes within the state. There is a distinct possibility that migration from Arizona will occur, if it has not already. Introductions into the Lake Powell region were likely a result of anglers from Arizona using this species as bait or possibly through aquarium releases (Wilson 2008).

Management considerations: Management of frog populations is difficult because of their juxtaposition to native species in shared aquatic habitats. Current control efforts range from removal of breeding adults to removal of all life stages. Adult frogs can be removed by trapping or hand captures. However, most mechanical methods are only successful in small areas, with limited populations (Pitt and Witmer 2006). Tadpoles can be destroyed by draining ponds or chemical treatment (Pitt and Sin 2004). Fencing may also be used to reduce spread of frogs from infested habitats (Pitt and Witmer 2006). The efficacy of previous efforts, as it relates to reduction in population growth or cost-effectiveness, has not been well evaluated (Govindarajulu et al. 2005).

Literature Cited:

Behler, J. L., and F. W. King. 1992. The Audubon Society field guide to North American reptiles and amphibians. Alfred A. Knopf, New York.

Conant, R. and J.T. Collins. 1998. A field guide to amphibians and reptiles: Eastern and Central North America. Third edition, expanded. Houghton Mifflin Company, Boston.

Davidson, C. 1996. Frog and toad calls of the Rocky Mountains. Library of Natural Sounds, Cornell Laboratory of Ornithology, Ithaca, New York.

Degenhardt, W.G., C.W. Painter and A.H. Price. 1996. Amphibians and reptiles of New Mexico. University of New Mexico Press, Albuquerque.

Dixon, J.R. 2000. Amphibians and reptiles of Texas: with keys, taxonomic synopses, bibliography, and distribution maps. W.L. Moody Jr. editor, Natural History Series, Number 25, Texas A&M University Press, College Station, Texas.

Garrett, J.M. and D.A. Barker. 1987. Field guide to reptiles and amphibians of Texas. Texas monthly field guide series, Gulf Publishing Company, Houston.

Govindarajulu, P., R. Altwegg, and B. R. Anholt. 2005. Matrix model investigation of invasive species control: bullfrogs on Vancouver Island. Ecological Applications 15(6):2161-2170.

Hillis, D.M. 1981. Premating isolating mechanisms among three species of the *Rana pipiens* complex in Texas and southern Oklahoma. Copeia 1981:312–319.

Hillis, D.M., J.S. Fros and D.A. Wright. 1983. Phylogeny and biogeography of the *Rana pipiens* complex: A biochemical evaluation. Systematic Zoology 32:132-143.

Jennings, M.R. and M.P. Hayes. 1994. Decline of native ranid frogs in the desert southwest. Pages 183-211. *In* P.R. Brown and J.W. Wright editors. Herpetology of the North American Deserts, Special Publication, Number 5, Southwestern Herpetologists Society, Van Nuys, California.

Platz, J.E. 1972. Sympatric interaction between two forms of leopard frog (*Rana pipiens* complex) in Texas. Copeia 1972:232–240.

Platz, J.E., R.W. Clarkson, J.C. Rorabaugh and D.M. Hillis. 1990. *Rana berlandieri*: recently introduced populations in Arizona and southeastern California. Copeia 1990:324–333.

Platz, J.E. 1991. Rana berlandieri. Catalogue of American amphibians and reptiles: 508.1-508.4.

Pitt, W. C., and G. W. Witmer. 2006. Invasive predators: a synthesis of the past, present, and future. Wildlife Damage Management, Internet Center for USDA National Wildlife Research Center – Staff Publications. University of Nebraska, Lincoln.

Pitt, W. C. and H. Sin. 2004. Dermal toxicity of citric ascid based pesticides to introduced Eleutherodactylus frogs in Hawaii. USDA, APHIS, WS, NWRC. Hilo, Hawaii.

Rorabaugh, J.C., M.J. Sredl, V. Miera and C.A. Drost. 2002. Continued invasion of an introduced frog (*Rana berlandieri*): southwestern Arizona, southeastern California, and Rio Colorado, Mexico. Southwestern Naturalist 47:12–20.

Rorabaugh, J. C. 2008. Personal communication. United States Fish and Wildlife Service. Phoenix, Arizona.

Stebbins, R. C. 2003. A Field Guide to Western Reptiles and Amphibians. 3rd Edition. Houghton Mifflin Company, New York.

Wilson K. 2008. Personal communication. Utah Division of Wildlife Resources, Native Species Coordinator. Salt Lake City, Utah

Rio Grande Leopard Frog- *Rana Berlandieri*

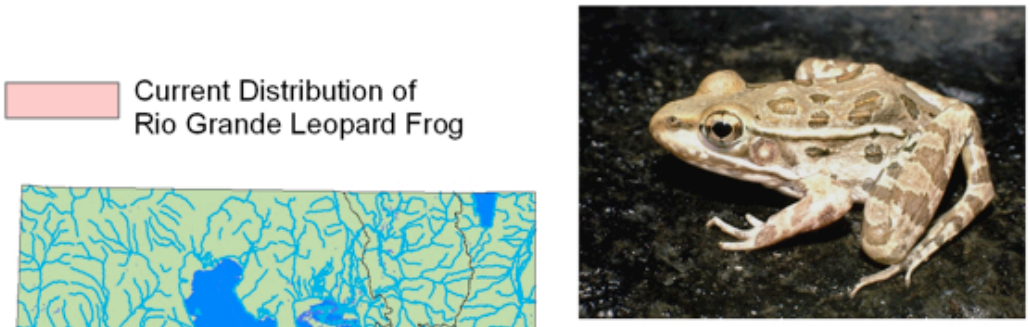
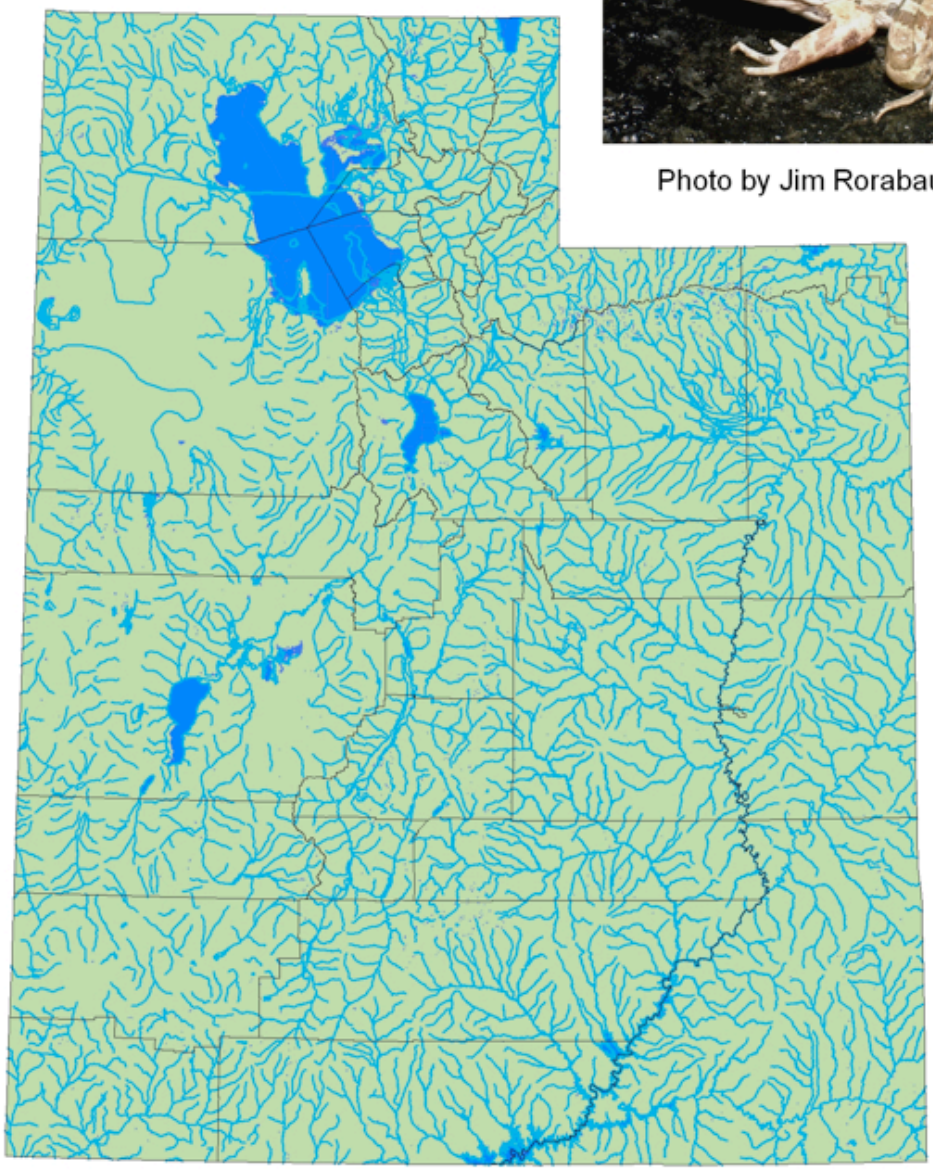


Photo by Jim Rorabaugh



REPTILES

Red-Eared Slider *Trachemys scripta elegans*

Ecology: Red-eared sliders (*T. scripta elegans*) can be distinguished from all other North American turtles by the presence of a broad red stripe behind the eye. Some specimens, especially older males, become melanistic or black, which makes identification challenging (Dundee and Rossman 1989; Conant and Collins 1991; Tucker et al. 1995).

T. scripta elegans are found both in fresh and brackish waters including coastal marsh ponds (Dundee and Rossman, 1989). *T. scripta elegans* prefer quiet water with a muddy bottom and abundant vegetation, they can also be found in moving waters, though less frequently. They can often be seen basking on rocks, logs, vegetation masses, and on banks (Mount, 1975; Behler, 1979; Dundee and Rossman, 1989; Conant and Collins, 1991). *T. scripta elegans* is sensitive to cold temperatures.

Mortality rates are high among the young, though; adults are believed to live as long as 50-75 years (Dundee and Rossman 1989). Although significant differences in growth rates have been documented between populations (Tucker et al. 1998), female red-eared sliders are typically larger than males (Gibbons and Lovich 1990). Males mature when they reach a plastron length of 90-100 mm, between 2-5 years of age. Females mature at plastron lengths between 150 and 195 mm (Ernst and Barbour 1972). Courtship occurs in spring and fall, and has been reported as highly stereotyped (Dundee and Rossman 1989; Lovich et al. 1990). Nests are excavated along the banks well above water, or sometimes, considerable distances from the water (Mount, 1975). Nests are excavated to a depth of 120-140 cm (Packard et al. 1997). In Louisiana, eggs are deposited from late March to mid July. Clutch size varies from 2 to19 eggs, but are typically between 7 and 13 eggs (Dundee and Rossman, 1989; Tucker and Janzen, 1998). Eggs are white and usually measure between 23.5 and 44.2 mm in length and 18.4 to 24.6 mm in width (Dundee and Rossman 1989). Eggs hatch in approximately 68-70 days and newborns are 20-35 mm long (Dundee and Rossman 1989). Chen and Lue (1998) reported eggs incubated under lab conditions, to hatch in 75 days. Up to three clutches may be laid per season. As is the case with other turtles, sex determination of hatchlings is temperature dependent (Lockwood et al. 1991). Most hatchlings overwinter in their nest (Mount 1975; Packard et al. 1997). Sexual maturity is reached in two to five years (Dundee and Rossman 1989).

Distribution: Because of the frequency of introductions of this subspecies, its natural range in North America is not fully known (Holman 1994). Red-eared sliders are believed to naturally occur in the Mississippi valley from northern Illinois and Indiana to the northern Gulf of Mexico, west to Texas and east to western Alabama (Holman 1994).

T. scripta elegans now occurs throughout Utah (Figure 1). Most sightings are likely a result of escaped or released pets. However, breeding populations have established in numerous locations (Pers. Comm. Richard Hepworth. 2008. Southern Region Assist. Aquatic Program Manager, Utah Division of Wildlife Resources; Pers. Comm. Mike Ottenbacher. 2008; Southern Region Aquatic Program Manager, Utah Division of Wildlife Resources; Pers. Comm. Craig Schaugarrd. 2008. Northern Region Aquatic Program Manager, Utah Division of Wildlife Resources). Reproducing populations in Utah are generally found in regions with warmer

climates, artificial ponds such as community fisheries, and warm springs. Packard et al. (1997) suggests that the depth to which the soil freezes in the winter might limit the northern extent of this species in Illinois. Isolated populations occurring in Michigan, suffer heavy mortalities in the winter, surviving mostly in artificial ponds (Holman, 1994).
Pathways of Introduction: *Trachemys scripta* was introduced into the wild in Europe because pet turtles were released by their owners. Red-eared sliders commonly sold in the pet trade across the United States (Dundee and Rossman, 1989). Close and Seigel (1997) reported approximately 26 million red-eared sliders were exported from the U.S. to international markets between 1988 and 1994. Concern, over the possible establishment of this species throughout the world, has been raised (Newberry, 1984; Bouskila, 1986; Da Silva and Blasco, 1995; Chen and Lue, 1998).

T. scripta will most likely be unsuccessful in spreading throughout Utah. Generally, it is only observed at localities where humans release individuals. Since it rarely manages to breed under outdoor, natural or semi-natural conditions (so far mainly in Southern Utah and isolated areas with specific habitat conditions in Northern Utah), *T. scripta* will only be able to increase its distribution by additional releases.

Management Considerations: Negative impacts of *Trachemys scripta* on natural habitats and ecosystems are unknown. The vast majority of individuals are observed in urban parks and other urban areas of limited ecological value. Potentially, *T. scripta* may be released in other natural habitats with high ecological value, especially close to urban areas. Should that occur, it would be relevant to monitor any possible impact to native flora and fauna, which would typically include: invertebrates, amphibians, native turtles (*E. orbicularis*) and nesting birds.

Any further efforts to reduce releases of pet turtles in the wild should include information outreach. Targeted public awareness campaigns should be aimed at informing pet owners to obtain sufficient information about the animals in advance, to care well for them and never to release them in the wild.

It is possible that individuals of *T. scripta* may be released in ponds or other freshwater bodies compromising valuable ecological systems with rare amphibians, fish, birds or plants. In such cases it may be considered necessary to eradicate the turtles. In our climate, *T. scripta* will have to bask on land regularly in order to maintain an optimal body temperature. Thus, in sunny weather turtles will be easy to spot while basking on logs, branches, rocks, banks and other suitable terrestrial places very close to the water. This behavior would aid in detection and capture.

Literature Cited:

Behler, J.L. 1979. The Audubon Society field guide to North American reptiles and amphibians. Alfred A. Knopf, Inc., New York.

Bouskila, A. 1986. On the danger of the red-eared terrapin, *Chrysemys scripta*, in natural habitats in Israel. Hardun 3:63.

Chen, T., and K. Lue. 1998. Ecological notes on feral populations of *Trachemys scripta elegans* in northern Taiwan. Chelonian Conservation and Biology 3(1):87-90.

Close, L.M., and R.A. Seigel. 1997. Differences in body size among populations of

red-eared sliders (*Trachemys scripta elegans*) subjected to different levels of harvesting. Chelonian Conservation and Biology 2(4):563-566.
Conant, R., and J.T. Collins. 1991. Reptiles and amphibians. eastern/central North America. Houghton Mifflin Co., Boston.
Da Silva, E., and M. Blasco. 1995. *Trachemys scripta elegans* in southwestern Spain. Herpetological Review 26(3):133-134.
Dundee, H.A., and D.A. Rossman. 1989. Amphibians and Reptiles of Louisiana. State University Press, Baton Rouge, Louisiana.
Ernst, C. H. and R. W. Barbour. 1972. Turtles of the United States. University Press of Kentucky. Lexington.
Gibbons, J.W., and J.E. Lovich. 1990. Sexual dimorphism in turtles with emphasis on the slider turtle (*Trachemys scripta*). Herpetological monographs 4:1-29.
Holman, J.A. 1994. Status of the red-eared slider turtle *Trachemys scripta elegans* (Weid) in Michigan: A preliminary report. Michigan Academician 26:471-477.
Lockwood, S.F., B.S. Holland, J.W. Bickham, B.G. Hanks, and J.J. Bull. 1991. Intraspecific genome size variation in a turtle (*Trachemys scripta*) exhibiting temperature-dependent sex determination. Canadian Journal of Zoology 69:2306-2310.
Lovich, J.E., W.R. Garstka, and W.E. Cooper, Jr. 1990. Female participation in courtship behavior of the turtle *Trachemys scipta scripta*. Journal of Herpetology 24(4):422-424.
Mount, R.H. 1975. The reptiles and amphibians of Alabama. Auburn Printing Co., Auburn, New York.
Newberry, R. 1984. The American red-eared terrapin in South Africa. African Wildlife 38:186-189.
Packard, G.C., J.K. Tucker, D. Nicholson, and M.J. Packard. 1997. Cold tolerance in hatching slider turtles (*Trachemys scripta*). Copeia 1997(2):339-345.
Tucker, J.K., and J. Janzen. 1998. Order of oviposition and egg size in the red-eared slider turtle (*Trachemys scripta elegans*). Canadian Journal of Zoology 76:377-380.
Tucker, J.K., F.J. Janzen, and G.L. Paukstis. 1998. Variation in carapace morphology and reproduction in the red-eared slider *Trachemys scripta elegans.* Journal of Herpetology 32(2):294-298.
Tucker, J.K., R.J. Maher, C.H. Theiling. 1995. Melanism in the red-eared slider (*Trachemys scripta elegans*). Journal of Herpetology 29(2):291-296.

Red-Eared Slider- *Trachemys scripta elegans*

Current Distribution of Red-Eared Slider

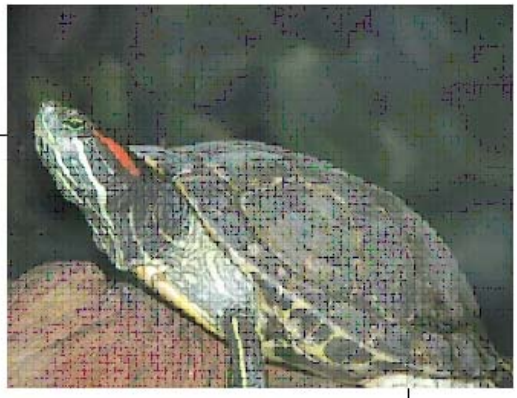
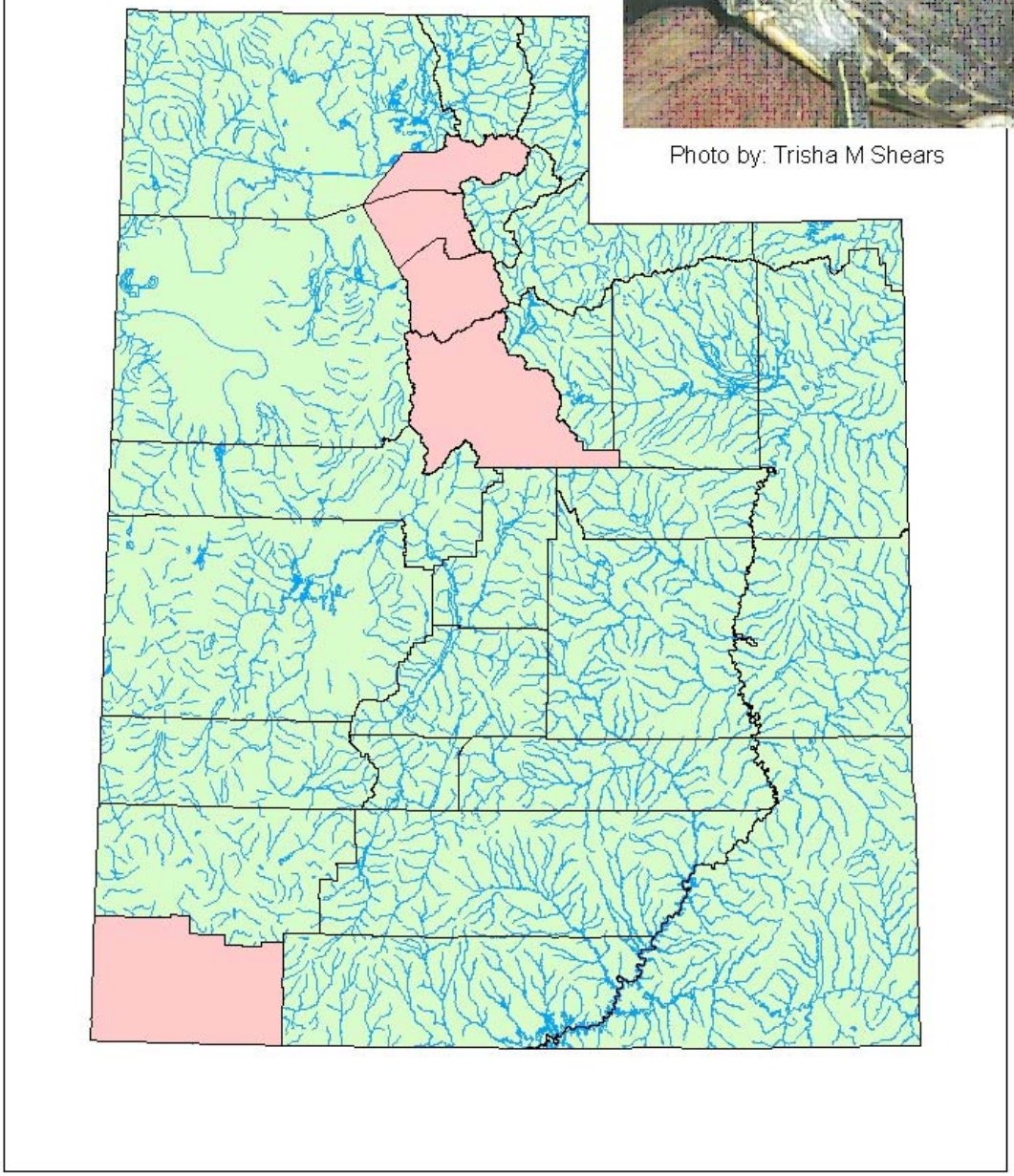


Photo by: Trisha M Shears



APPENDIX B

STATE OF UTAH DEPARTMENT OF NATURAL RESOURCES POLICIES AND PROCEDURES	REF. NR-07-D-11	PAGE 1 of 5
	EFFECTIVE DATE 03/19/07	
	REVISION DATE	
SUBJECT: Prevent Invasion Of Zebra Mussel Into Utah Waters		
Michael R. Styler, Executive Director		

I. PURPOSE

To define the policy of the Department of Natural Resources (Department) that will provide direction on the prevention of Zebra mussel infestation into Utah's waters.

II. POLICY

It is the policy of the Department to prevent the infestation of Zebra mussel (*Dreissena* sp.) into Utah's waters. Divisions of the Department will cooperate and provide resources to prevent infestation by:

a. Planning and implementing interdiction and containment efforts to prevent infestation of Zebra mussel into Utah's waters.
b. Assisting with monitoring efforts to document the absence or presence of Zebra mussel.
c. Informing the public on Zebra mussel impacts, prevention measures, and monitoring updates; and
d. Inviting other government agencies (including adjoining states) and non-governmental organizations to participate and provide resources (interdiction, monitoring, and conservation outreach) to prevent infestation of Zebra mussel into Utah's waters. The development of cooperative agreements with these agencies and organizations may be considered as part of this mutual process.

III. AUTHORITY

Authority is vested under Sections 23-13-5 and 23-20-1 of the Utah Wildlife Code. The Utah Wildlife Board, under Rule 657-3-22 (w) for Collection, Importation and Possession of wildlife species in Utah, identified *Dreissena* species as prohibited.

IV. PROCEDURE

a. Prevention:
The Department will take the lead in reconvening the state's Aquatic Nuisance Species (ANS) Team to address the prevention of Zebra mussel infestation into Utah. The ANS Team will include those affected parties wishing to participate.

i. The Division of Wildlife Resources is designated as the lead Division for the Department.

ii. The Department will ask the ANS Team to assist in developing cooperative interdiction efforts between the Department, National Park Service, other federal agencies, inter- and intra-state agencies and their respective agencies, municipalities, public utilities, private industry and other relevant parties that address preventative measures for Zebra mussel infestation. Interdiction efforts include, but are not limited to, law enforcement checks and boat and equipment disinfection. The initial interdiction efforts have been started at the Lake Powell National Recreation Area due to its proximity to infected waters and high boating use.

iii. The Department will assist the ANS Team in conducting a risk assessment of Utah waters with high potential for Zebra mussel infestation. Thereafter the Department will help direct long-term interdiction efforts on these prioritized state waters (e.g., Quail Creek, Sand Hollow, and Gunlock reservoirs).

iv. The ANS Team will be strongly urged by the Department to support the interagency development of individual Hazard Analysis and Critical Control Point (HACCP) plans at these high-risk waters.

v. The Department will assist the ANS Team in identifying and pursuing cooperative funding packages for the interdiction efforts to support increased boat checks at high-risk waters, and development of boat cleaning stations that follow 100th Meridian protocol. (See www.100thMeridian.org).

vi. The Department will ask the ANS Team to coordinate their interdiction efforts with those Department Divisions with law enforcement authority and the Utah Attorney General's office to review, clarify and pursue laws and rules that will help with these prevention measures.

b. Monitoring:
The Department will support the ANS Team to cooperatively develop and implement monitoring efforts at priority waters, based on the aforementioned risk assessment, to determine the presence or absence of Zebra mussel. Monitoring has already been started at Lake Powell. The Department will assist with the following:
   i. Use monitoring protocol identified by the 100th Meridian group to insure continuity throughout interstate water systems.
   ii. Identify and pursue cooperative funding packages within the monitoring programs to support biologically sound sampling methods, and a long term Zebra mussel database housed within the Department.
   iii. Coordinate monitoring efforts with public water utilities and private industry to help track infestation potential. All monitoring will provide annual sampling results for the Department's Zebra mussel database.

c. Conservation Outreach:
The Department will support the ANS Team to cooperatively develop and implement conservation outreach efforts to prevent Zebra mussel infestation into state waters.
   i. The Department will assist the ANS Team in developing and utilizing public information signs, media coverage and messages (e.g., brochures) consistent with other states and the 100th Meridian group related to Zebra mussel infestation. Immediate efforts should be directed toward Lake Powell, as well as other high-risk waters.

ii. The Department will coordinate with other states and the 100th Meridian to develop common messages, and to share information on infestation reports or possible management/control research.

iii. The Department will work with interested partners to develop a long-term education program to inform the public of the need for proper boating disinfection when moving between waters.

V. BACKGROUND

The state of Utah, under direction of the Department of Natural Resources, recognizes that *Dreissena* mussels (commonly referred to as Zebra mussels) are a harmful aquatic nuisance species not native to Utah. They originate from the drainage systems of the Black and Caspian seas in Eastern Europe. These mussels were first discovered in the United States in the Great Lakes (Lake St. Clair) around 1986-1988. Since that time, Zebra mussels have spread throughout the eastern United States due to the absence of natural predators, high reproductive potential, adaptability to available aquatic habitats, and unintentional human transport. Expanding populations of these species are now found throughout the Mississippi, Missouri, and Arkansas River drainages. Reported densities from the Great Lakes area are over 100,000 mussels per square meter at some facilities.

One of the *Dreissena* mussel species (Quagga mussel) was recently discovered during January 2007 in Lake Mead and other downstream reservoirs of the lower Colorado River. This finding in the Colorado River system expands the documented range of invasion by over 1000 miles from previously known locations to the east. The proximity of these reservoirs to those located upstream in Utah significantly increases the risk that *Dreissena* mussels could infest state waters. Infestation events are usually first documented in or around boating facilities on waters, indicating a strong correlation to their being transported through boating and other aquatic related activities. Irrigation and other water delivery systems, common throughout Utah's arid environments, are other pathways whereby aquatic invasive species can be transported.

The infestation of *Dreissena* mussels (hereafter called Zebra mussels) in the eastern United States has caused millions of dollars of economic loss to public agencies and private industry. Zebra mussel can severely hinder the delivery of

STATE OF UTAH DEPARTMENT OF NATURAL RESOURCES POLICIES AND PROCEDURES	REF. NR-07-D-11	PAGE 5 of 5
	EFFECTIVE DATE 03/19/07	
	REVISION DATE	
SUBJECT: Prevent Invasion Of Zebra Mussel Into Utah Waters		
Michael R. Styler, Executive Director		

water for domestic, municipal, industrial, and agricultural purposes due to their ability to clog or foul pipes, pumps, water intake screens, water treatment facilities, power plant intakes and cooling systems, and fish screens. The boating industry incurs additional recreation costs associated with boat and motor damage, cleaning costs, and disinfection needs required for containment at infected waters. Public safety has also been documented as a hazard to those using the beach areas on recreational waters (unprotected feet) due to the sharpness of the bivalve shells.

Ecologically, zebra mussels alter aquatic environments by filtering from the water the essential nutrients and green algae that form the base of the food chain required by native species and sport fish for growth and survival. A major concern is the potential impacts from infestation to Utah's native sensitive species, which have already declined to low population levels due to other negative factors such as habitat loss. Other concerns include potential impacts to important recreational fisheries and the potential to interfere with irrigation, municipal and industrial water delivery facilities.

Several years ago, a group was formed under the direction of the U.S. Fish and Wildlife Service to address the spread of invasive species, such as Zebra mussels. The group was named the "100th Meridian" because Zebra mussels were not found west of this longitude line at the time of organization. To date there is no known method to eradicate them after establishment. Prevention through education and interdiction are the first lines of defense against invasion of these species. The 100th Meridian group has facilitated communication and cooperative efforts among stakeholders to educate and contain Zebra mussels; and to share current management ideas on limiting impacts from them once infestation has occurred.

To protect and preserve public safety of Utah's citizens, its critical water resources and uses, the economy of its aquatic based recreation and its valuable fish and wildlife resources, the Department of Natural Resources has developed a

policy that will provide direction on the prevention of infestation of Zebra mussels into the State's waters. This policy also addresses the need to form partnerships with other governmental agencies and private industry to coordinate and ensure its successful implementation.

APPENDIX C

BUDGET REQUEST
For
"A QUAGGA MUSSEL EDUCATION AND IMPLEMENTAION PLAN"

Utah Department of Natural Resources
Utah Division of Wildlife Resources
Preparer: Walt Donaldson, Aquatic Chief

October 3, 2007

A. **Proposal**: To educate the public about aquatic nuisance species, particularly Quagga and Zebra mussel impacts, and prevent their invasion into Utah's waters.

B. **Work Schedule**: Fiscal Year 2008 & 2009

C. **Authority**: 1) UCA Title 23, Wildlife Code; 2) Rule 657-3, Collection, Importation and Possession of zoological Animals; and 3) DNR Policy #NR-07-D-11, "Prevent Invasion of Zebra Mussel into Utah Waters"

D. **Need**: Quagga and Zebra mussels are exotic, invasive species from east central Russia that annually have caused millions of dollars of impacts to water resource based industries and water recreation in the eastern United States over the last two decades. Quagga mussels were discovered in Lake Mead on the lower Colorado River in January 2007. Then, in August 2008 veligers (microscopic larval form of Quagga and Zebra mussels), presumably of Quagga mussels due to the proximity of Lake Mead, were identified in Lake Powell.

The purpose of this proposal is to fund a program to educate the public about aquatic nuisance species, particularly Quagga and Zebra mussel impacts, and prevent their invasion into other Utah waters. Within Utah there are 21 boating lakes and reservoirs that have state park facilities, and there are 46 boating lakes and reservoirs without a state park. The state of Minnesota, "land of 10,000 lakes," has been very successful in limiting expansion of invasive mussel species in their waters through aggressive education and prevention efforts. This proposal is patterned after Minnesota's plan.

E. **Tasks**:

1. Administration and Monitoring (Aquatic Section)

- Administer and coordinate interagency education and prevention efforts statewide, particularly with both state and local water conservation agencies.

- Develop and implement a strategic plan and associated action plans regarding aquatic nuisance species in cooperation with participating agencies (e.g. water conservation districts, local governments, federal and state land and natural resource management agencies, NGO organizations and other private partners) to prevent or slow the spread of invasive species infestation within Utah.
- Take the lead on work planning, evaluation, budget development, monitoring and reporting.
- Conduct risk assessments of key state waters and prioritize them based on their potential for invasion or containment of an invasion.
- Recruit, train and supervise 5 Wildlife Biologist I (AL) and 22 seasonal (AJ) Wildlife Technicians on how to:
  a) Educate the public about aquatic nuisance species and mussel impacts;
  b) Conduct approved inspections for Quagga and Zebra mussels on or contained within watercraft;
  c) Conduct approved inspections for Quagga and Zebra mussels on watercraft hauling vehicles and trailers;
  d) Conduct approved inspections for Quagga and Zebra mussels on water-related recreational equipment; and
  e) Conduct biological sampling for Quagga and Zebra mussels.
- Implement watercraft inspections for Quagga and Zebra mussels at Utah's high-risk lakes and reservoirs to insure compliance, and compel watercraft users or haulers to decontaminate boats, trailers, and water-related recreational equipment as needed, particularly those originating from waters with high invasive potential for Quagga and Zebra mussels.
- Distribute educational or outreach materials on invasive species as needed.
- In cooperation with land management agencies, install and maintain Quagga and Zebra mussel and/or aquatic nuisance species signs on all major lakes and reservoirs in Utah.
- Conduct biological sampling for Quagga and Zebra mussels in high-risk lakes and reservoirs throughout the state.
- Develop and maintain a database to track results from biological sampling of Quagga and Zebra mussels.
- Review technology and research updates on invasive mussel control and prevention.

2. Interdiction (Law Enforcement Section)

- Recruit, train and supervise 5 Conservation Officers on how to:
  a) Educate the public about aquatic nuisance species and mussel impacts;
  b) Conduct approved inspections for Quagga and Zebra mussels on or contained within watercraft;
  c) Conduct approved inspections for Quagga and Zebra mussels on watercraft hauling vehicles and trailers;
  d) Conduct approved inspections for Quagga and Zebra mussels on water-related recreational equipment; and

e) Conduct biological sampling for Quagga and Zebra mussels; and
f) Insure compliance with Utah's laws and rules.

- Implement watercraft inspections for Quagga and Zebra mussels at Utah's high-risk lakes and reservoirs to insure compliance, and compel watercraft users or haulers to decontaminate boats, trailers, and water-related recreational equipment as needed, particularly those originating from waters with high invasive potential for Quagga and Zebra mussels.
- Distribute educational or outreach materials on invasive species as needed.
- In cooperation with land management agencies, install and maintain Quagga and Zebra mussel and/or aquatic nuisance species signs on all major lakes and reservoirs in Utah.
- Conduct biological sampling for Quagga and Zebra mussels in high-risk lakes and reservoirs throughout the state.
- Implement boat and watercraft inspections for mussels at Utah's high-risk lakes and reservoirs, insure compliance, and collect biological samples from selected waters.
- Compel watercraft users or haulers to decontaminate boats, trailers, and water-related recreational equipment as needed.

Public Education and Information (Conservation Outreach Section)

- Recruit, train and supervise 1 Conservation Outreach Coordinator on how to educate DNR personnel, participating agencies and the public about aquatic nuisance species, particularly Quagga and Zebra mussel impacts, and prevention methods.
- Develop and implement a conservation outreach plan for aquatic nuisance species, particularly Quagga and Zebra mussels.
- Design and update printed education materials on aquatic nuisance species, particularly invasive mussels, in consultation with the Aquatic Nuisance Species Coordinator.
- Maintain and update the DWR website on aquatic nuisance species, particularly invasive mussels, and prevention efforts in consultation with the Aquatic Nuisance Species Coordinator.
- Conduct media coordination and advertisement to insure public awareness of the threat from aquatic nuisance species, particularly invasive mussels, and prevention methods.
- Develop and implement education plans to inform and train the boating industry about the threat from aquatic nuisance species, particularly invasive mussels, and prevention methods.

4. Cooperative Containment Efforts (Aquatic Section)

- Develop and implement action plans as needed for containment of aquatic nuisance species in cooperation with participating agencies (e.g. water conservation districts, local governments, federal and state land and natural resource management agencies, NGO organizations and other

private partners) to prevent the spread of invasive species from infested waters, particularly Quagga and Zebra mussels as follows:
a) Specifically and immediately focus upon Lake Powell.
b) Appropriately monitor for aquatic nuisance species infestations (e.g. collect zooplankton in reservoirs near high boat density sites—marinas, implement Portland substrate samplers, make visual inspections of underwater habitats using scuba equipment, and inspect intake and outlet or other plumbing structures). Then, submit samples as needed to qualified experts or labs as verification for presence or non-presence of aquatic nuisance species. **Note:** Regarding Lake Powell, analysis from the US Bureau of Reclamation lab in Denver, CO indicates extreme low densities of the Quagga mussel juveniles.
c) Focus upon other state waters as needed;
d) Cooperatively develop appropriate containment messages.

- Direct and coordinate efforts involving the use of conservation officers, biologists, wildlife technicians and participating agency personnel in contacting as many boaters and anglers as possible about aquatic nuisance species, particularly Quagga and Zebra mussels, to insure that watercraft enter and leave Utah's waters as "uncontaminated" (clean).

ESTIMATED BUDGET COSTS

FY 2008: $1,106,500
Supplemental Appropriation
*** See Excell File: FY08** Budget & Personnel Distribution for Sheehan.xls

FY 2009: $1,640,000
Building Block Appropriation
*** See Excell File: FY09** Budget & Personnel Distribution for Sheehan.xls

UTAH FISHING LAKES AND RESERVOIRS USED BY BOATERS

June 2008

Risk Ranking: 1 = highest; 2 = high; 3 = moderate; 4 = low; 5 = little to no risk

UDWR-NRO (Rank 1-5 & Recommendation Provided by Schaugaard 6-27-07)

1-Bear Lake SP, 2 inspectors & 1 boat decontamination unit
- 3-Cutler Reservoir
- 3-Newton Reservoir
- 4-Whitney Reservoir
- 4-Stateline Reservoir
- 5-Birch Creek Reservoir (no ramp)
- 4-Woodruff Reservoir

1-Pineview, 2 inspectors & 1 boat decontamination unit
- 5-Causey Reservoir (no ramp)

2-East Canyon SP, \
2-Rockport SP } 1 Inspector & 1 boat decontamination unit
2-Echo Reservoir /
- 4-Smith & Morehouse

4-Stateline Reservoir

- 4-Lost Creek Reservoir

1-Willard Bay SP, 2 inspectors & 1 boat decontamination unit
- 2-Hyrum SP,
- 2-Mantua Reservoir
- 4-Porcupine Reservoir

1-I-80 port (?)

UDWR-NERO (Rank 1-5 & Recommendation Provided by Schneidervin 7-03-07)

1-Flaming Gorge, 4 inspectors & 2 boat decontamination units
- 3-Calder Reservoir
- 3-Crouse Reservoir
- 3-Matt Warner Reservoir

3-Red Fleet SP and Steinaker SP, 1 inspector & 1 boat decontamination unit
- 4-Bough Reservoir

4-East Park Reservoir
4-Bullock Reservoir
4-Cottonwood Reservoir (low boat use)

1-Pelican Lake (due to tournaments), 1 inspector & 1 boat decontamination unit

3-Starvation SP, 1 inspector & 1 boat decontamination unit
4-Currant Creek Reservoir
4-Moon Lake
4-Big Sandwash Reservoir
5-Upper Stillwater Reservoir (no ramp)

UDWR-CRO (Rank 1-5 & Recommendation Provided by Wiley 6-28-07)

1-Strawberry Reservoir, 2 inspectors & 1 boat decontamination unit
1-Jordanelle SP, 2 inspectors & 1 boat decontamination unit (1% non-resident use from WY & NB, but Lk Mead destination)
2-Deer Creek SP, 1 inspector & 1 boat decontamination unit (low non-resident use)

2-Yuba SP, 1 inspector & 1 boat decontamination unit (8% non-resident use)
5-Gunnison Reservoir (no ramp & 3 miles dirt road for access)
4-Utah Lake SP, 2 inspectors & 1 boat decontamination unit
5-Mona Reservoir (poor sport fishery)

UDWR-SERO (Rank 1-5 & Recommendation Provided by Birdsey 7-03-07)

1-Huntington North SP, 1 inspector & 1 boat decontamination unit
3-Electric Lake
3-Mammoth Reservoir

2-Millsite SP, 1 inspector & 1 boat decontamination unit
2-Joes Valley Reservoir

1-Scofield SP, 1 inspector & 1 boat decontamination unit

Lake Powell
1-Bullfrog, 2 inspectors (NPS has 1 boat decontamination unit)
1-Hall's Crossing, 1 inspector (NPS has 1 boat decontamination unit)
NOTE: Vehicle may be needed for technician who works Hall"s Crossing, since the Technician would be housed at Bullfrog
5-Hite- cannot launch boats there in 2007, unknown 2008

Medium Risk Waters
3-Recapture Reservoir

Low Risk Waters:
4-Blanding #4
4-Kens's Lake

1-I-70 port (?)

UDWR-SRO (Rank 1-5 & Recommendation Provided by Ottenbacher 6-27-07)

1-Gunlock, Quail Creek and Sand Hollow SP, 3 inspectors & 2 boat decontamination units (Mar-Nov)
3-Upper and Lower Enterprise
3-Newcastle Reservoir

5-Fish Lake, 1 inspector & 1 boat decontamination unit (May-Aug)
2-Koosharem Reservoir

3-Otter Creek SP and Piute SP, 2 inspectors & 1 boat decontamination unit (April-Labor Day)

2-Minersville Reservoir, 1 inspector & 1 boat decontamination unit (April-Labor Day)
NOTE: County operated

1-Panguitch Lake, 1 inspector & 1 boat decontamination unit (May-Labor Day)
4-Navaho Lake
4-Kolob Reservoir

1-Lake Powell
Wahweap & Antelope Point/Stateline, 2 inspectors & NPS has 2 boat decontamination units (Mar-Nov)

1-I-15 Port of Entry, 2 inspectors & 2 boat decontamination units? (Mar-Nov)

1-West Lake Mead Access Pts, 1 contacter (Mar-Nov)

UTAH DIVISION OF WILDLIFE RESOURCES

NEW ZEALAND MUDSNAIL (*Potamopyrgus antipodarum*) MANAGEMENT PLAN

FOR LOA HATCHERY

Tim Miles, Plan Coordinator

March 3, 2008

Loa State Fish Hatchery Status

The aquatic invasive species New Zealand Mudsnail (NZMS) was found in the main spring complex and throughout the outside cement rearing system at the Loa Hatchery in late November 2007. Springs providing water for the hatchery building and truck loading system have remained free of NZMS. The Loa Hatchery is owned and operated by the Utah Division of Wildlife Resources (Division).

Purpose

To develop a NZMS management plan that addresses both the short term and long-term direction for the Loa Hatchery

Short Term strategy for decontamination of the existing trout stocks on station.

To determine extent of the NZMS infestation in fish groups at the Loa Hatchery, the staff sampled 100 fish from rearing units in the hatchery building and 100 fish from the large outside raceways. The stomachs and digestive tracts of each fish were physically examined for the presence of snails. Snails were to be identified as either an unknown native species or NZMS, but no snails were found in any of the fish sampled. These fish stocks will continue to be sampled at least quarterly until a determination is made to either stock them in waters already containing NZMS or destroy the fish.

1. Protocols for stocking infested fish from the Loa Hatchery into NZMS infested waters:
    a. A minimum of quarterly, sample 100 fish from the hatchery building and 100 fish from the outside raceway system to determine the presence of NZMS. Each fish's stomach and digestive tract will be examined for the presence of snails by lethal, ocular and microscopic inspection.
    b. Fish scheduled for stocking will be placed in the raceway system that has been cleaned as follows:
        i. Use a high-pressure hot water washer, spraying 140 degree F. water at a point 12 inches from the nozzle, to remove all sludge, vegetation, and snails, paying particular attention to seams, corners, screen channels and backing boards.
        ii. After pressure washing, spray the inside of the raceway with a quaternary ammonium compound that contains the active ingredient - Alkyl dimethyl benzyl ammonium chloride (ADBAC), at a concentration of 5.0%. Then, allow the raceway to sundry for 48 hours, if possible.
        iii. The cleaned and disinfected raceway will be filled with filtered water from the hatchery building water supply.

1. Sack or screen filters, capable of filtering particles larger than 150 microns, will be used to filter all water coming into the raceways.
2. Water level and flow for the raceways will be set at a depth to maintain a minimum velocity of 0.25 feet per second. This flow will move any previously ingested NZMS discharged by the fish through the system.

iv. All fish scheduled for stocking will be moved into the cleaned and disinfected raceway, and held 96 hours prior to stocking.

v. Immediately prior to stocking, the presence of NZMS will be determined by examining the complete digestive tract of 100 fish as described above.

1. If no snails are found in the sampled fish, the lot of fish in the raceway will be considered free of NZMS and stocked into waters infested with NZMS. Appendix A, lists waters currently infested with NZMS.
    a. All water used to transport fish to stocking location will be filtered with a 100 micron bag filter.
2. If 1 or more snails are found in a sample, the group will be held for 7 more days in a disinfected raceway. Fish will be feed normally for the first 5 days and held off food for the last 2 days. At the end of the 7-day holding period, another sample of 100 fish will be collected and checked for the presence of snails.
3. If no snails are founds, the group will be considered free of snails and stocked into NZMS infested waters.
    a. If 1 or more snails are found then fish will not be stocked. Fish well be removed from the disinfected raceway and placed into another raceway. The filters and water supply for the disinfected raceway will be evaluated for NZMS presence. If filter or water supply problems are found, they will be fixed and the raceway will be re-disinfected following the protocol outlined in subsections 1.b.i and 1.b.ii. Fish will then be moved back into this raceway 96 hours prior to stocking and subsection 1.b.iii.v.1 through 1.b.iii.v.3 will be repeated.

c. The Loa Hatchery staff will modify their current HACCP plan to include dealing with the presence of NZMS and ensure that all operations at the hatchery follow the plan.

d. The Fisheries Experiment Station (Logan) will continue to conduct research on other NZMS control methods.

2. The Division of Wildlife Resources (Division) Aquatics Section will maintain a current list of all waters in the state infested with New Zealand Mudsnail. The Aquatic Invasive Species Coordinator (AIS Coordinator) will be responsible for keeping the list up-to-date.

The Division will make the final determination if it is in the best interest of the State to stockfish that might be infested with NZMS. If the decision is to not stock the fish currently held at the Loa Hatchery, then the fish will be killed, buried in quick lime, the hatchery disinfected, cleaned and closed until funds can be procured to collect the springs and rebuild the water delivery system and raceways.

Long term Strategy to contain the springs at the Loa Hatchery and remove NZMS from the hatchery

1. Potential methods to remove NZMS from the hatchery's water supply can be lumped into four categories – (a) chemical treatment, (b) filtration, (c) collection and burial (Cut-off trench) and (d) drilling a well.

    a. Chemical treatment of the water delivery/drain systems and rearing units is the only sure way to remove snails from the system. Initial investigation of the main spring indicates that there are several native snail species present. As a result, chemical treatment of the water supply would be unacceptable, without removing or relocating these native species first. A thorough inventory of all plant, animal and mollusk species in the complex will have to be conducted prior to permitting work in the area. There are several categories of chemicals that work well to kill NZMS with a short contact time. The categories are:
        i. Quaternary ammonium compounds (alkyl dim-ethyl benzyl ammonium chloride (ADBAC) – active ingredient listed as 0.3% or greater); NZMS are killed when exposed to the following concentration for 10 minutes: The following are examples of some of the ADBAC compounds that can be used: 4.6% QUAT 128 solution (1 Liquid oz. QUAT 128 per gallon water = 6.4 oz/gal.; 1 gallon QUAT 128 per 100 gallons = 5 %) OR STEPANQUAT 50 NF (HYAMINE) solution (1.3 ml STEPANQUAT 50 NF (HYAMINE 50% Active Ingredients) per gallon water = 187 ppm or 5.0% solution).
        ii. Placing 4 inch wide copper strips or painting bans of cuprous oxide-based marine antifouling paint or cuprous thiocyanate-based marine antifouling paint on the waterside of a hatchery's outfall structure may help to keep snails from moving upstream.
        iii. During daily operations it is important to not cross-contaminate areas of the hatchery with NZMS transported on footwear or equipment. Shoes, boots, waders, and other equipment having contact with hatchery water should have all attached debris removed. Scrub with a stiff-bristled brush, then visually inspect, since snails frequently collect between the laces and tongue of footwear and on/in felt soles. Follow the inspection with tap water rinse, where possible. Then, either (1) Spray gear with Formula 409 (the correct Formula 409 product lists dim-ethyl benzyl ammonium chloride as 0.3%) to kill snails. Contact time should be at least 30 minutes. Or, (2) Spray gear with copper sulfate solution having a concentration of 252 mg/l of copper to kill snails (1 oz of Copper Sulfate powder/10 gallons of water). Requires a contact time of more than 5 minutes.

            Note: In either case, allow gear to dry as much as possible prior to reuse.

        iv. If decontaminating large pieces of equipment, use a quaternary ammonium compound with a 50% active ingredient of ADBAC, which can be purchased in 5, 15 and 55-gallon drums from bulk chemical distributors.
        v. Other processes (require research to determine effectiveness)
            1. Electrical fields
            2. Ionization and magnetic arrays

    b. Filtration of the water delivery system.
        i. Mature NZMS range in size from 3 to 6 mm, while immature snails will range from 0.16 to 0.6 mm. Filtration media needs to be capable of filtering particles

smaller than 160 microns, preferably in the 100 micron range, and be able to handle large amounts of the vegetation and debris that are normally washed into the system. Method for filtering NZMS from the hatchery's water supply include:

1. Bag filters are available in the opening size required to remove NZMS and are economical. In order to handle the flows required at the Loa Hatchery, a large array of filters would have to be set up with a method of pre-filtration to remove moss, weeds, twigs etc. Once a filter is plugged it has to be physically removed and replaced with a new filter. This process would make the installation labor intensive.
2. Drum and Disc filters would handle the incoming flows but experience has shown that these filters, though capable of filtering out small particles allow some particles to bypass the filtration process due to seal problems between the drum and frame.
3. Membrane filtration – There are a number of membrane filter on the market that are capable of filtering NZMS from the water supply, they all require pumps to move water through the filters and operate the back wash system. We would like to keep the Loa Hatchery as pump free as possible.

c. Collection and burial of the water delivery system.
    i. The "Feasibility Study for Improvements and Construction of Fish Hatcheries" completed by FishPro in October 1996. In the "Loa Hatchery Enhancement Plan" it was recommended that the hatchery's water system be collected in a cut-off trench drain.
        1. The drain would be installed down slope from the impervious layer to intercept water flows emerging from the hillside above the hatchery. The bottom of the trench would be set into the impervious layer to ensure no water leaks under the trench.
        2. An impervious fabric would be placed on the bottom and down slope side of the trench to dam up water flowing off of the impervious layer. A perforated pipe and a filter material (sand or gravel) is then placed in the trench to collect water dammed by the trench and a compacted soil layer of clay would cap the trench to keep surface water from infiltrating the collection system.
d. Well drilling alternative
    i. Ben Everitt with the Utah Division of Water Resources proposed collecting water from the spring source at Loa Hatchery using wells, in 2002. The Loa springs emerge directly from bedrock to the west of the hatchery. The aquifer is capped with an impervious volcanic tuff that prevents surface contamination. Mr. Everitt proposed two options depending on the actual configuration of the aquifer:
        1. If the spring orifices are compact sources emerging from rock, then spring boxes could be constructed on rock foundations as needed to collect water
        2. If the aquifer is extensive or diffuse, with spring sources controlled by unconsolidated material or willow roots, a drain trench with perforated pipe in a gravel envelope could be used similar to collection system proposed by FishPro.

    Extensive investigation of the spring area would be required prior to accepting either option.

Of the proposed solutions to remove and keep snails out of the spring complex at Loa, collection and burial of the water delivery system alternatives appears to be the most secure alternative. Collecting process water before it is exposed to the surface will prevent exposure to NZMS and other aquatic invasive species, fish diseases and other surface contaminants into the future. Without a secure water source that is free of aquatic invasive species and pathogens the hatchery will continue to be susceptible to any number of problems. Any work performed on the piping and rearing units would be temporary at best. This proposal will be subject to permitting by the Army Corps of Engineers, a feasibility study and engineers working closely with a wetland specialist and geologist to ensure sufficient water is collected to operate the hatchery at its pre-NZMS infestation level.

2. Methods to permanently remove NZMS from the hatchery's water distribution system and rearing units.
    a. NZMS infestation in the spring complex has to be addressed prior to considering any program to remove snails from the piping and rearing units.
    b. Depopulate the hatchery of fish stocks and divert all water from the facility.
    c. Place 4 inch wide copper sheeting to the inside surfaces of all hatchery outlet structures.
    d. Piping should have the copper attached to the inside surface of the pipe, with a minimum of 1 inch of copper extending beyond the end of the pipe
        i. Raceways or distribution boxes discharging directly into a settling basin or stream should have the copper striping attached continuously from the top of side wall across the floor and to the top of the adjacent side wall. The strip should be attached within two inches of the end of the structure.
        ii. Starting at the piping system closest to the spring, use a power washer capable of producing 140 degree F. water 12 inches from the sprayer nozzle. Clean all sludge, scale, vegetation and dirt from rearing units and the interior surfaces of accessible water distribution pipes. Pay particular attention to cracks, seams, joints, screen slot and any areas where snails might hide, and work to the bottom of the hatchery.
    e. After the facility has been cleaned, spray all surfaces, including all interior surfaces of all water distribution pipes, with a 5.0% solution of quaternary ammonium.
    f. In areas where the water distribution pipes cannot be cleaned or power washed, completely fill the system with a 5.0% solution of quaternary ammonium and allow to stand a minimum of 4 hours.
    g. Allow the facility to air dry at least two weeks.

Recommendations for a long term solution to the NZMS problem at the Loa Hatchery

It is the Division's intent to pursue the water collection and containment alternative. The long-term development at the Loa Hatchery addresses the presence of NZMS in the adjacent watershed and provides a water supply and facility that will prevent reintroduction. The following issues will have to be addressed in order to keep NZMS from being reintroduced and protect native snails in the spring complex.

1. Determine the feasibility of collecting the entire spring source or sufficient water to operate the hatchery at its pre NZMS levels or above.
2. Conduct an inventory of the spring complex to identify all species of mollusks, plants and aquatic organisms, especially native species of special concern.
3. Work with the Army Corps of Engineers to obtain necessary permit to work in wetland areas to collect water at the spring complex and rebuild the water supply system and rearing units.
4. Work to provide funding for a complete hatchery rebuild; or at a minimum, collection of the spring complex. The feasibility study conducted by FishPro in 1996 estimated collection of the

spring complex and rebuild of the hatchery building and raceways at $3.7 million; in 2008 dollars the project is estimated at $6,500,000. The cost of only collecting the spring in 1996 was estimated at $192,000; in 2008 dollars the project could cost above $450,000.

5. Develop a plan to accommodate native species found in the spring complex.
6. Ensure that the amount of water returned to Spring Creek will full fill the irrigation water right of down stream water users.
7. Ensure that the construction phase for water collection addresses: daily decontamination of site, decontamination of equipment and by-pass of surface water to retain wetland values.
8. Ensure that new facilities are secure enough to prevent contamination by ground water, mammals, birds and humans (water tight water transmission lines, covered raceways, barriers to prevent upstream movement of mollusks).
9. Maintain a disinfection station with a hot water pressure washer and containment drainage system.
10. Do not allow visitors inside of the production facilities.
11. Follow the "Hatchery Sampling and Cleaning Protocols" (Appendix B) to ensure quarterly NZMS sampling and equipment methods are consistent and approved.
12. Maintain an up-to-date HACCP plan (Appendix C) and ensure that all steps are followed.

The Fisheries Experiment Station at Logan will continue to research methods to control or kill New Zealand Mudsnails, refine protocols to prevent movement between waters and purging snails from infested fish prior to stocking.

This plan was taken to the Wildlife Board on April, 10, 2008 for their review and comment.

APPROVED BY:_____

Walter Donaldson, Aquatics Program Chief Date

Appendix E1

Aquatic Invasive Species Interdiction Act

1st Sub. S.B. 238

LEGISLATIVE GENERAL COUNSEL

6 Approved for Filing: E.R. Brown 6

6 02-25-08 11:52 AM 6

S.B. 238

1st Sub. (Green)

SB0238S01

Senator Jon J. Greiner proposes the following substitute bill:

AQUATIC INVASIVE SPECIES

INTERDICTION ACT

2008 GENERAL SESSION

STATE OF UTAH

Chief Sponsor: Jon J. Greiner

House Sponsor: Stephen H. Urquhart

LONG TITLE

General Description:

This bill amends and enacts provisions relating to the interdiction of invasive species.

Highlighted Provisions:

This bill:

< defines terms;

< prohibits the possession, release, or transportation of a Dreissena mussel;

< prohibits the transporting of a conveyance or equipment that has been in an infested water without decontaminating the conveyance or equipment;

< requires a person who violates the chapter to reimburse the state's costs;

< establishes criminal penalties;

< authorizes the Division of Wildlife Resources to:

C stop, detain, inspect, impound, or quarantine a vehicle or vessel that may contain a Dreissena mussel;

C conduct an administrative checkpoint;

C order a person to decontaminate a vessel or vehicle; and

C inspect, restrict access to, or close a water body, facility, or water supply system;

< prohibits the Division of Wildlife Resources from closing or quarantining a water

1st Sub. (Green) S.B. 238 02-25-08 11:52 AM

supply system if a plan is implemented;

< requires the Division of Wildlife Resources to consult with an operator of a water body, facility, or water supply system;

< requires a water supply system to cooperate with the Division of Wildlife Resources and implement a plan if infected with the Dreissena mussel;

< requires a person to report the discovery of a Dreissena mussel to the Division of Wildlife Resources;

< authorizes the Wildlife Board to make rules; and

< authorizes the division, a peace officer, or a port-of-entry agent to stop a driver at a port-of-entry to check for invasive aquatic wildlife species.

Monies Appropriated in this Bill:

None

Other Special Clauses:

None

Utah Code Sections Affected:

AMENDS:

72-9-501, as last amended by Laws of Utah 2005, Chapter 2

ENACTS:

23-27-101, Utah Code Annotated 1953

23-27-102, Utah Code Annotated 1953

23-27-201, Utah Code Annotated 1953

23-27-202, Utah Code Annotated 1953

23-27-301, Utah Code Annotated 1953

23-27-302, Utah Code Annotated 1953

23-27-303, Utah Code Annotated 1953

23-27-401, Utah Code Annotated 1953

Be it enacted by the Legislature of the state of Utah:

Section 1. Section **23-27-101** is enacted to read:

CHAPTER 27. AQUATIC INVASIVE SPECIES INTERDICTION ACT

Part 1. General Provisions

23-27-101. Title.

This chapter is known as the "Aquatic Invasive Species Interdiction Act."

Section 2. Section **23-27-102** is enacted to read:

23-27-102. Definitions.

As used in this chapter:

(1) "Board" means the Wildlife Board.

(2) (a) "Conveyance" means a terrestrial or aquatic vehicle or a vehicle part that may carry or contain a Dreissena mussel.

(b) "Conveyance" includes a motor vehicle, a vessel, a motorboat, a sailboat, a personal watercraft, a container, a trailer, a live well, or a bilge area.

(3) "Director" means the director of the division.

(4) "Decontaminate" means to:

(a) drain and dry all non-treated water; and

(b) chemically or thermally treat in accordance with rule.

(5) "Division " means the Division of Wildlife Resources.

(6) "Dreissena mussel" means a mussel of the genus Dreissena at any life stage, including a zebra mussel, a quagga mussel, and Conrad's false mussel.

(7) "Equipment" means an article, tool, implement, or device capable of carrying or containing:

(a) water; or

(b) a Dreissena mussel.

(8) "Executive director" means the executive director of the Department of Natural Resources.

(9) "Facility" means a structure that is located within or adjacent to a water body.

(10) "Infested water" means a geographic region, water body, facility, or water supply

system within or outside the state that the board identifies in rule as carrying or containing a
Dreissena mussel.
(11) "Water body" means natural or impounded surface water, including a stream, river, spring, lake, reservoir, pond, wetland, tank, and fountain.
(12) (a) "Water supply system" means a system that treats, conveys, or distributes water for irrigation, industrial, waste water treatment, or culinary use.

(b) "Water supply system" includes a pump, canal, ditch, or pipeline.
(c) "Water supply system" does not include a water body.
Section 3. Section **23-27-201** is enacted to read:
Part 2. Invasive Species Prohibited
23-27-201. Invasive species prohibited.
(1) Except as authorized in this title or a board rule or order, a person may not:
(a) possess, import, export, ship, or transport a Dreissena mussel;
(b) release, place, plant, or cause to be released, placed, or planted a Dreissena mussel in a water body, facility, or water supply system; or
(c) transport a conveyance or equipment that has been in an infested water within the previous 30 days without decontaminating the conveyance or equipment.
(2) A person who violates Subsection (1):
(a) is strictly liable;
(b) is guilty of an infraction; and
(c) shall reimburse the state for all costs associated with detaining, quarantining, and decontaminating the conveyance or equipment.
(3) A person who knowingly or intentionally violates Subsection (1) is guilty of a class A misdemeanor.
Section 4. Section **23-27-202** is enacted to read:
23-27-202. Reporting of invasive species required.
(1) A person who discovers a Dreissena mussel within this state or has reason to believe a Dreissena mussel may exist at a specific location shall immediately report the discovery to the division.
(2) A person who violates Subsection (1) is guilty of a class A misdemeanor.
Section 5. Section **23-27-301** is enacted to read:
Part 3. Enforcement
23-27-301. Division's power to prevent invasive species infestation.
To eradicate and prevent the infestation of a Dreissena mussel, the division may:
(1) temporarily stop, detain, and inspect a conveyance or equipment that:
(a) the division reasonably believes is in violation of Section 23-27-201; or
(b) is stopped at a port-of-entry;

(2) require a motor vehicle transporting a conveyance or equipment to stop for an inspection at a port-of-entry if the Department of Transportation authorizes the division to use the port of entry;
(3) conduct an administrative checkpoint in accordance with Section 77-23-104;
(4) detain and quarantine a conveyance or equipment as provided in Section 23-27-302;
(5) order a person to decontaminate a conveyance or equipment; and
(6) inspect the following that may contain a Dreissena mussel:
(a) a water body;
(b) a facility; and

(c) a water supply system.
Section 6. Section **23-27-302** is enacted to read:
23-27-302. Conveyance or equipment detainment or quarantine.
(1) The division, a port-of-entry agent, or a peace officer may detain or quarantine a conveyance or equipment if:
(a) the division, agent, or peace officer:
(i) finds the conveyance or equipment contains a Dreissena mussel; or
(ii) reasonably believes that the person transporting the conveyance or equipment is in violation of Section 23-27-201; or
(b) the person transporting the conveyance or equipment refuses to submit to an inspection authorized by Section 23-27-301.
(2) The detainment or quarantine authorized by Subsection (1) may continue for:
(a) up to five days; or
(b) the period of time necessary to:
(i) decontaminate the conveyance or equipment; and
(ii) ensure that a Dreissena mussel is not living on or in the conveyance or equipment.
Section 7. Section **23-27-303** is enacted to read:
23-27-303. Closing a water body, facility, or water supply system.
(1) Except as provided by Subsection (6), if the division detects or suspects a Dreissena mussel is present in a water body, a facility, or a water supply system, the director or the director's designee may, with the concurrence of the executive director, order:

(a) the water body, facility, or water supply system closed to a conveyance or equipment;
(b) restricted access by a conveyance or equipment to a water body, facility, or water supply system; or
(c) a conveyance or equipment that is removed from or introduced to the water body, facility, or water supply system to be inspected, quarantined, or decontaminated in a manner and for a duration necessary to detect and prevent the infestation of a Dreissena mussel.
(2) If a closure authorized by Subsection (1) lasts longer than seven days, the division shall:
(a) provide a written update to the operator of the water body, facility, or water supply system every ten days on the division's effort to address the Dreissena infestation; and
(b) post the update on the division's website.
(3) (a) The board shall develop procedures to ensure proper notification of a state, federal, or local agency that is affected by a Dreissena mussel infestation.
(b) The notification shall include:
(i) the reasons for the closure, quarantine, or restriction; and
(ii) methods for providing updated information to the agency.
(4) When deciding the scope, duration, level, and type of restriction or a quarantine or closure location, the director shall consult with the person with the jurisdiction, control, or management responsibility over the water body, facility, or water supply system to avoid or minimize disruption of economic and recreational activity.
(5) (a) A person that operates a water supply system shall cooperate with the division to implement a measure to:
(i) avoid infestation by a Dreissena mussel; and
(ii) control or eradicate a Dreissena mussel infestation that may occur in a water supply system.
(b) (i) If a Dreissena mussel is detected, the water supply system's operator, in

cooperation with the division, shall prepare and implement a plan to control or eradicate a
Dreissena mussel within the water supply system.
(ii) A plan required by Subsection (5)(b)(i) shall include a:
(A) method for determining the scope and extent of the infestation;

(B) method to control or eradicate the Dreissena mussel;
(C) method to decontaminate the water supply system containing the Dreissena mussel;
(D) systematic monitoring program to determine a change in the infestation; and
(E) requirement to update or revise the plan in conformity with a scientific advance in the method of controlling or eradicating a Dreissena mussel.
(6) (a) The division may not close or quarantine a water supply system if the operator has prepared and implemented a plan to control or eradicate a Dreissena mussel in accordance with Subsection (5).
(b) (i) The division may require the operator to update a plan.
(ii) If the operator fails to update or revise a plan, the division may close or quarantine the water supply system in accordance with this section.
Section 8. Section **23-27-401** is enacted to read:
Part 4. Administration
23-27-401. Rulemaking authority.
In accordance with Title 63, Chapter 46a, Utah Administrative Rulemaking Act, the board may make rules that:
(1) establish the procedures and requirements for decontaminating a conveyance or equipment to prevent the introduction and infestation of a Dreissena mussel;
(2) establish the requirements necessary to provide proof that a conveyance or equipment is decontaminated;
(3) establish the notification procedures required in Section 23-27-303;
(4) identify the geographic area, water body, facility, or water supply system that is infested by Dreissena mussels;
(5) establish a procedure and protocol in cooperation with the Department of Transportation for stopping, inspecting, detaining and decontaminating a conveyance or equipment at a port-of-entry in accordance with Section 23-27-301; and
(6) are necessary to administer and enforce the provisions of this chapter.
Section 9. Section **72-9-501** is amended to read:
72-9-501. Construction, operation, and maintenance of ports-of-entry by the department -- Function of ports-of-entry -- Checking and citation powers of port-of-entry agents.

(1) (a) The department shall construct ports-of-entry for the purpose of checking motor carriers, drivers, vehicles, and vehicle loads for compliance with state and federal laws including laws relating to:
(i) driver qualifications;
(ii) Title 53, Chapter 3, Part 4, Uniform Commercial Driver License Act;
(iii) vehicle registration;
(iv) fuel tax payment;
(v) vehicle size, weight, and load;
(vi) security or insurance;
(vii) this chapter;
(viii) hazardous material as defined under 49 U.S.C. 5102;

223 (ix) livestock transportation; and
224 (x) safety.
225 (b) The ports-of-entry shall be located on state highways at sites determined by the
226 department.
227 (2) (a) The ports-of-entry shall be operated and maintained by the department.
228 (b) A port-of-entry agent or a peace officer may check, inspect, or test drivers, vehicles,
229 and vehicle loads for compliance with state and federal laws specified in Subsection (1).
230 (3) (a) A port-of-entry agent or a peace officer, in whose presence an offense described
231 in this section is committed, may:
232 (i) issue and deliver a misdemeanor or infraction citation under Section 77-7-18;
233 (ii) request and administer chemical tests to determine blood alcohol concentration in
234 compliance with Section 41-6a-515;
235 (iii) place a driver out-of-service in accordance with Section 53-3-417; and
236 (iv) serve a driver with notice of the Driver License Division of the Department of
237 Public Safety's intention to disqualify the driver's privilege to drive a commercial motor
vehicle
238 in accordance with Section 53-3-418.
239 (b) This section does not grant actual arrest powers as defined in Section 77-7-1 to a
240 port-of-entry agent who is not a peace officer or special function officer designated
under Title
241 53, Chapter 13, Peace Officer Classifications.
242 (4) (a) A port-of-entry agent, a peace officer, or the Division of Wildlife Resources

243 may inspect, detain, or quarantine a conveyance or equipment in accordance with
Sections
244 23-27-301 and 23-27-302.
245 (b) The department is not responsible for decontaminating a conveyance or equipment
246 detained or quarantined.
247 (c) The Division of Wildlife Resources may decontaminate, as defined in Section
248 23-27-102, a conveyance or equipment at the port-of-entry if authorized by the
department.

APPENDIX E2

R657. Natural Resources, Wildlife Resources.
R657-60. Aquatic Invasive Species Interdiction.

R657-60-1. Purpose and Authority.

(1) The purpose of this rule is to define procedures and regulations designed to prevent and control the spread of aquatic invasive species within the State of Utah.

(2) This rule is promulgated pursuant to authority granted to the Wildlife Board in Sections 23-27-401, 23-14-18, and 23-14-19.

R657-60-2. Definitions.

(1) Terms used in this rule are defined in Section 23-13-2 and 23-27-101.

(2) In addition:

(a) “Conveyance” means a terrestrial or aquatic vehicle, including a vessel, or a vehicle part that may carry or contain a Dreissena mussel.

(b) "Decontaminate” means to:

(i) Self-decontaminate equipment or a conveyance that has been in an infested water in the previous 30 days by:

(A) removing all plants, fish, mussels and mud from the equipment or conveyance;

(B) draining all water from the equipment or conveyance, including water held in ballast tanks, bilges, livewells, and motors; and

(C) drying the equipment or conveyance for no less than 7 days in June, July and August;18 days in September, October, November, March, April and May; 30 days in December, January and February; or expose the equipment or conveyance to sub-freezing temperatures for 72 consecutive hours; or

(ii) Professionally decontaminate equipment or a conveyance that has been in an infested water in the previous 30 days by:

(A) Using a professional decontamination service approved by the division to apply scalding water (140 degrees Fahrenheit) to completely wash the equipment or conveyance and flush any areas where water is held, including ballast tanks, bilges, livewells, and motors.

(c) “Dreissena mussel” means a mussel of the genus Dreissena at any life stage, including a zebra mussel, a quagga mussel and a Conrad’s false mussel.

(d) “Controlling entity” means the owner, operator, or manager of a water body, facility, or a water supply system.

(e) “Equipment” means an article, tool, implement, or device capable of carrying or containing water or Dreissena mussel.

(f) “Facility” means a structure that is located within or adjacent to a water body

(g) “Infested water” includes all the following:

(i) Electric Lake, Utah;

(ii) Grand Lake, Colorado;

(iii) Jumbo Reservoir, Colorado;

(iv) lower Colorado River between Lake Mead and the Gulf of California;
(v) Lake Granby, Colorado;
(vi) Lake Mead in Nevada and Arizona;
(vii) Lake Mohave in Nevada and Arizona;
(viii) Lake Havasu in California and Arizona;
(ix) Lake Pueblo in Colorado;
(x) Lake Pleasant in Arizona;
(xi) San Justo Reservoir in California;
(xii) Southern California inland waters in Orange, Riverside, San Diego, Imperial, and San Bernardino counties;
(xiii) Shadow Mountain Reservoir, Colorado;
(xiv) Tarryall Reservoir, Colorado;
(xv) Willow Creek Reservoir; Colorado;
(xvi) coastal and inland waters east of the100th Meridian in North America; and
(xvii) other waters established by the Wildlife Board and published on the DWR website.
(h) “Vessel” means every type of watercraft used or capable of being used as a means of transportation on water.
(i) “Water body” means natural or impounded surface water, including a stream, river, spring, lake, reservoir, pond, wetland, tank, and fountain.
(j) “Water supply system” means a system that treats, conveys, or distributes water for irrigation, industrial, wastewater treatment, or culinary use, including a pump, canal, ditch or, pipeline.
(i) “Water supply system” does not included a water body.

R657-60-3. Possession of Dreissena Mussels.
(1) Except as provided in Subsections R657-60-3(2) and R657-60-5(2), a person may not possess, import, ship, or transport any Dreissena mussel.
(2) Dreissena mussels may be imported into and possessed within the state of Utah with prior written approval of the Director of the Division of Wildlife Resources or a designee.

R657-60-4. Reporting of invasive species required.
(1) A person who discovers a Dreissena mussel within this state or has reason to believe a Dreissena mussel may exist at a specific location shall immediately report the discovery to the division.
(2) The report shall include the following information:
(a) location of the Driessena mussels;
(b) date of discovery;
(c) identification of any conveyance or equipment in which mussels may be held or attached; and
(d) identification of the reporting party with their contact information.
(3) The report shall be made in person or in writing:
(a) at any division regional or headquarters office or;
(b) to the division’s toll free hotline at 1-800-662-3337; or

(c) on the division's website at www.wildlife.utah.gov/law/hsp/pf.php.

R657-60-5. Transportation of equipment and conveyances that have been in infested waters.

(1) The owner, operator, or possessor of any equipment or conveyance that has been in an infested water shall:

(a) immediately drain all water from the equipment or conveyance at the take out site, including water held in ballast tanks, bilges, livewells, motors, and other areas of containment; and

(b) immediately inspect the interior and exterior of the equipment or conveyance at the take out site for the presence of Dreissena mussels.

(2) If all water in the equipment or conveyance is drained and the inspection undertaken pursuant to Subsection (1)(b) reveals the equipment and conveyance are free from mussels or shelled organisms, fish, plants and mud, the equipment and conveyance may be transported in or through the state directly from the take out site to the location where it will be:

(a) professionally decontaminated; or

(b) stored and self-decontaminated.

(3) If all the water in the equipment or conveyance is not drained or the inspection undertaken pursuant to Subsection (1)(b) reveals the equipment or conveyance has attached mussels or shelled organisms, fish, plants, or mud, the equipment and conveyance shall not be moved from the take out site until the division is contacted and written or electronic authorization received to move the equipment or conveyance to a designated location for professional decontamination.

(4) A person shall not place any equipment or conveyance that has been in an infested water in the previous 30 days into any other water body or water supply system in the state without first decontaminating the equipment or conveyance.

R657-60-6. Certification of Decontamination

(1) The owner, operator or possessor of a vessel desiring to launch on a water body in Utah must:

(a) verify the vessel and any launching device have not been in an infested water in the previous 30 days; or

(b) certify the vessel and launching device have been decontaminated.

(2) Certification of decontamination is satisfied by:

(a) previously completing self-decontamination since the vessel and launching device were last in an infested water and completely filling out and dating a decontamination certification form which can be obtained from the division; or

(b) providing a signed and dated certificate by a division approved professional decontamination service verifying the vessel and launching device were professionally decontaminated since the vessel and launching device were last in an infested water.

(3) Both the decontamination certification form and the professional decontamination certificate, where applicable, must be signed and placed in open view in the window of the launching vehicle prior to launching or placing the vessel in a body of water.

(4) It is unlawful under Section 76-8-504 to knowing falsify a decontamination certification form.

R657-60-7. Wildlife Board designations of infested waters.

(1) The Wildlife Board may designate a geographic area, water body, facility, or water supply system as infested with Dreissena mussels pursuant to Section 23-27-102 and 23-27-401 without taking the proposal to or receiving recommendations from the regional advisory councils.

R657-60-8. Closure Order for a Water Body, Facility, or Water Supply System.

(1)(a) If the division detects or suspects a Dreissena mussel is present in a water body, facility, or water supply system, the division director or designee may, with the concurrence of the executive director, issue an order closing the water body, facility, or water supply system to the introduction or removal of conveyances or equipment.

(b) The director shall consult with the controlling entity of the water body, facility, or water supply system when determining the scope, duration, level and type of closure that will be imposed in order to avoid or minimize disruption of economic and recreational activities.

(2)(a) A closure order issued pursuant to Subsection (1) shall be in writing and identify the:

(i) water body, facility, or water supply system subject to the closure order;

(ii) nature and scope of the closure or restrictions;

(iii) reasons for the closure or restrictions;

(iv) conditions upon which the order may be terminated or modified; and

(v) sources for receiving updated information on the status of infestation and closure order.

(b) The closure order shall be mailed, electronically transmitted, or hand delivered to:

(i) the controlling entity of the water body, facility, or water supply system; and

(ii) any governmental agency or private entity known to have economic, political, or recreational interests significantly impacted by the closure order; and

(iii) any person or entity requesting a copy of the order.

(c) The closure order or its substance shall further be:

(i) posted on the division's web page; and

(ii) published in a newspaper of general circulation in the state of Utah or the affected area.

(3) If a closure order lasts longer than seven days, the division shall provide the controlling entity and post on its web page a written update every 10 days on its efforts to address the Dreissena mussel infestation.

(a) The 10 day update notice cycle will continue for the duration of the closure order.

(4)(a) Notwithstanding the closure authority in Subsection (1), the division may not unilaterally close or restrict a water supply system infested with Dreissena mussels where the controlling entity has prepared and implemented a control plan in cooperation with the division that effectively eradicates or controls the spread of Dreissena mussels from the water supply system.

(b) The control plan shall comply with the requirements in R657-60-9.

R657-60-9. Control plan required

(1) The controlling entity of a water body, facility, or water supply system may develop and implement a control plan in cooperation with the division prior to infestation designed to:

(a) avoid the infestation of Dreissena mussels; and

(b) control or eradicate an infestation of Dreissena mussels that might occur in the future.

(2) A pre-infestation control plan developed consistent with the requirements in Subsection (3) and approved by the division will eliminate or minimize the duration and impact of a closure order issued pursuant to Section 23-27-303 and R657-60-8.

(3) Upon detection of a Dreissena mussel and issuance of a division closure order involving a water body, facility, or water supply system without an approved control plan, the controlling entity shall cooperate with the division in developing and implementing a control plan to address the:

(a) scope and extent of the infestation;

(b) actions proposed to control the pathways of spread of the infestation;

(c) actions proposed to control or eradicate the infestation;

(d) methods to decontaminate the water body, facility, or water supply system, if possible;

(e) actions required to systematically monitor the level and extent of the infestation; and

(f) requirements and methods to update and revise the plan with scientific advances.

(4) Any post-infestation control plan prepared pursuant to Subsection (3) shall be approved by the Division before implementation.

R657-60-10. Procedure for Establishing a Memorandum of Understanding with the Utah Department of Transportation.

(1) The division director or designee shall negotiate an agreement with the Utah Department of Transportation for use of ports of entry for detection and interdiction of Dreissena Mussels illegally transported into and within the state. Both the Division of Wildlife Resources and the Department of Transportation must agree upon all aspects of Dreissena Mussel interdiction at ports of entry.

(2) The Memorandum shall include the following:

(a) methods and protocols for reimbursing the department for costs associated with Dreissena Mussel interdiction;

(b) identification of ports of entry suitable for interdiction operations;

(c) identification of locations at a specific port of entry suitable for interdiction operations;

(d) methods and protocols for disposing of wastewater associated with decontamination of equipment and conveyances;

(e) dates and time periods suitable for interdiction efforts at specific ports of entry;

(f) signage notifying motorists of the vehicles that must stop at the port of entry for inspection;

(g) priorities of use during congested periods between the department's port responsibilities and the division's interdiction activities;

(h) methods for determining the length, location and dates of interdiction;

(i) training responsibilities for personnel involved in interdiction activities; and

(j) methods for division regional personnel to establish interdiction efforts at ports within each region.

R657-60-11. Penalty for Violation.

A violation of any provision of this rule is punishable as provided in Section 23-13-11.

KEY: fish, wildlife, wildlife law
Date of Enactment or Last Substantive Amendment: January 7, 2009
Notice of Continuation: New Rule
Authorizing, and Implemented or Interpreted Law: 23-27-401; 23-14-18; 23-14-19

Appendix F

Asian Tapeworm (***Bothriocephalus acheilognathi***) Host List

Hosts[1,1a,2,3,4]

Potential hosts are any fish that eat the intermediate copepod hosts (*Cyclops* and *Diaptomus*). Primary hosts are cyprinoids (carps, minnows, suckers, etc.). It also infects some centrarchids (sunfish family), percids (perch, walleye, sauger, pike), poecilids (live bearers), siluroids (catfishes). The Asian tapeworm is non-host specific. It only requires two hosts, instead of the usual three hosts for cestodes.[4] It has not yet been reported in salmonids.

North American hosts include (1) cyprinoids such as the grass carp (*Ctenopharygodon idella*), common carp and koi (*Cyprinus carpio*), roundtail chub (*Gila robusta*), bonytail chub, virgin spinedace (*Lepidomeda mollispinis*), peamouth (*Mylocheilus*), golden shiner (*Notemigonus crysoleucas*), emerald shiner (*Notropis atherinoides*), red shiner (*Notemigonus lutrensis*), spotfin shiner (*Notropis spilopterus*), fathead minnow (*Pimephales promelas*), woundfin minnow (*Plagopterus argentissimus*), Colorado squawfish (*Ptychocheilus lucius*), speckled dace (*Rhinichthys osculus*); (2) green sunfish (*Lepomis cyanellus*), a centrarchid; and (3) the poecilid mosquito fish (*Gambusia affinis*).[1a]

Utah hosts include species infected in the Virgin River such as roundtail chub, woundfin minnow, speckled dace, red shiner, and virgin spinedace. In Utah Valley, infected fish are grass carp and fathead minnow. The source of the worm in the Virgin River / Lake Meade area was from infected bait minnows from the Midwest used by fishermen.[1,3]

European hosts are perch (*Stizostedion*), catfish (*Silurus glanus*), crucian carp (*Carassius carassius*), guppies (*Lebistes*), and mosquito fish.[1a]

The worm has never been found in bass (anywhere). It has not been found in percids (yellow perch, walleye, sauger, and pike) in North America. In the U.S., goldfish (*Carassius auratus*) appear to be refractory to infection.[1a]

References

1. Personal communication between A. K. Hauck and Dick Heckmann, Professor of Zoology, BYU, in October 1993, June 1994, April and June 1996.

1a. Personal communication between A. K. Hauck and Drew Mitchell, US National Biological Survey, Stuttgart, AR, in October 1993, August 1994, June 1995, and April 1996.

2. Thoesen, John C., Editor. 1994. Suggested procedures for the detection and identification of certain finfish and shellfish pathogens. 4th ed., Version 1, Fish Health Section, American Fisheries Society.
3. Heckmann, R. A., Greger, P. D. and J. E. Deacon. The Asian Fish Tapeworm Infecting Endangered Fish Species from the Virgin River, Utah, Nevada, and Arizona. FHS/AFS Newsletter, 1986. 14(1):5
4. Heckmann, R. A. Praziquantel for Treatment of Grass Carp Infected with *Bothriocephalus acheilognathi.* FHS/AFS Newsletter, 1995. 23(3):11-13.

07/04 AKH

APPENDIX G

Public Review
Utah Aquatic Invasive Species Management Plan

The Utah Aquatic Invasive Species Management Plan was initially launched for statewide public review as information at the Utah Wildlife Board's five Regional Advisory Council's meetings and at a Utah Wildlife Board meeting between May 27 and June 19, 2008. Review of the plan for final action was again brought before the public at the five Regional Advisory Councils and the Wildlife Board between August 12 and August 28, 2008. The plan was also available on the Internet for public review at http://wildlife.utah.gov/invasivespecies/aisplan/, which is located on Utah Division of Wildlife Resources' web site.

Additionally, the plan was presented to the Utah Governor's Office of Panning and Budget Resource Development Coordination Committee in their October 10, 2008 hearing. Comments received from statewide federal, state, and local government participants across a 30 day window via that process all recognized need for the plan and were all supportive for plan implementation.

The public review process involving the Utah Wildlife Board's five Regional Advisory Council's spanned a period of more than 90 days and included 10 public hearings before Utah's five Regional Advisory Councils, and two public hearings before the Utah Wildlife Board. Ultimately, the Utah Wildlife Board unanimously approved the plan on August 28, 2007. Public comments received on the plan in that process are as follow:

Internet Comments
No comments on the plan were received directly from the aforementioned website, which allowed the public to respond directly to the Utah Division of Wildlife Resources via an email link titled DWRComment@utah.gov.

Telephone Comments
Multiple telephone calls inquiring about the overall *Dreissena* mussel threat to Utah's waters, and requests for information about how to properly decontaminate a watercraft exposed to AIS were received by Utah Division of Wildlife Resources' offices during the public comment period. None of the calls originated due to the public review of the plan, and a similar rate of calls had occurred prior to the public comment period due to an aggressive, ongoing statewide "CLEAN, DRAIN and DRY" media campaign targeted at boaters.

Written Comments
No written comments were received by Utah Division of Wildlife Resources as a result of the public review of the plan.

Southern Regional Advisory Council (RAC)

The meeting agenda included multiple topics; comments, discussion and motions relative to the Utah Aquatic Invasive Species Management Plan follow:

May 27, 2008 Cedar City, UT**:** Chair Jake Albrecht called the meeting to order; there were 293 interested parties in attendance in addition to the Regional Advisory Council members, Wildlife Board members and Utah Division of Wildlife Resources employees.

Douglas Messerly, Utah Division of Wildlife Resources Regional Supervisor, briefed the meeting attendees saying, "Things that are happening within the Division, those of you that are fishing southern region waters may have run into some of our technicians that we've hired to assist in the effort to interdict boats with Quagga mussels, which is an agenda item tonight, an invasive mussel that's found in Nevada. Currently, we're tying to keep them from establishing in Utah. We're trying to educate the public and ask for your help in keeping this invasive species out of our state."

Larry Dalton, Utah Division of Wildlife Resources'AIS Coordinator, presented the Utah Aquatic Invasive Species Management Plan as an informational item using PowerPoint. The plan's Executive Summary was provided and the RAC was advised that the plan would be briefly presented again in August, seeking approval. Additionally, Utah Division of Wildlife Resources Law Enforcement Chief, Mike Fowlks, followed Larry Dalton, and presented Rule R657-60, Aquatic Invasive Species Interdiction as a PowerPoint for approval action (it passed unanimously). Questions from the RAC and the public, RAC discussions, and answers from both presenters relate directly to the AIS management plan, so both are included in this summary.

Questions From RAC:

Jake Albrecht (Q): In a water that freezes over for the wintertime, does that kill that particular type of mussel?

Larry Dalton (A): No. Great example here is the Great Lakes. If you've been there you've had opportunity to fish through the ice. They freeze up real good. You can drive trucks out there. These mussels are alive and well in the Great Lakes. The mussel has to be frozen, and if he's under the ice he's in water that's not frozen, or in the mud, on rocks whatever. So a frozen lake, unless it freezes right to the bottom and freezes the bottom hard is the only way they would die. And that would be a fishless lake every spring.

Jake Albrecht (Q): Okay, second part, is it going to be mandatory at our port of entries to pull boats over?

Larry Dalton (A): We are, Captain Fowlks will address that issue but I will speak to that very briefly. We are currently working with the Department of Transportation to use the ports of entry to do checks there. And yes we could, could and will under the authority of law use the ports of entry in the State of Utah.

Sam Carpenter (Q): Did I hear you correctly that Lake Powell is infected with these?

Larry Dalton (A): No, Lake Powell, uh, a year ago in August we did detect the veliger for this critter in Lake Powell. We took samples and sent them to three labs. One lab gave us a positive hit, both visually and with DNA analysis, which is called PCR. Two other labs could not find it with visual inspection under a microscope. And so if you can't find it

visually then you don't run the DNA test. So what we have is a situation where we're on very high alert at Lake Powell but we don't, at least we're not saying at this point in time that Lake Powell is an infested water. It won't be listed in our new law as infested. But we're taking samples on a real regular basis down there, and if it does show up then we would take emergency action with the Wildlife Board to list Lake Powell. But today we believe Lake Powell is not infested, but we're on high alert there. That's it. I've told you the facts; we've seen them, they just may not have taken. Or maybe they did and we just haven't found more of them yet. I'm not sure. We're spending a lot of energy down there checking that out.
Jack Hill (Q): You indicated scalding the mussels at 140-degree temperature.
Larry Dalton (A): Yes.
Jack Hill (Q): Is there a chemical that can be used to combat them?
Larry Dalton (A): There actually are a couple of chemicals around. They take quite a bit of contact time. Potassium chloride, the same salt you use in your water softener, at 100 parts per million will kill them but it take twelve hours of contact time. So if you happen to have one of these ski boats with the big ballast in it that never drains, you can inject that into that ballast and of course it sits around at your house for twelve hours or wherever, that will kill them. There is also a chemical called, its manufactured name is Rydlyme. If you spray it on them in about, in a few minutes actually it dissolves the shell off of a ¼ inch sized one and that kills it. So there are some other things out there. Rydlyme is, boaters are always concerned about what it is he's pumping inside of his boat and spraying around on it. And the salt, it doesn't hurt other aquatic species. You can kill at 100 parts per million and safe drinking is 250 parts per million.
Jake Hill (Q): I was thinking something like chlorine bleach.
Larry Dalton (A): Chlorine also kills. I apologize that I forgot the contact time on it but it's fairly long. Chlorine is quite caustic so, you can put it on real strong but real strong also is damaging your equipment. So chlorine is used at times but it's not the best tool. There's, the hot water is the very best tool because it pretty much represents a no impact to your equipment and kills the critter on contact.
Rex Stanworth (Q): Mike, these decontamination centers, obviously I guess your just in the preliminary, how many of those will there be and will there be any at the lake side? In other words like at Strawberry, or Bear Lake or some of the premier areas?
Michael Fowlks (A): Larry could probably answer this better than I. We have two decontamination centers set up at Lake Powell now that are permanent. The Division has purchased portable decontamination centers as well. And I can't tell you how many we've got; Larry can answer that.
Larry Dalton (A): Thanks Mike. As Mike said, Lake Powell, the National Park Service has two on Lake Powell, one at Bull Frog, one at Wahweep. The Division of Wildlife Resources has 26 decontamination units. They are trailer mounted and they are scattered all over the state of Utah. And pretty much they would be within an hour's distance of most boating waters to move one over or to send a boater in that direction. We'll learn more about that as we get through life a little bit here of how effective we can be. And the decontamination takes about half an hour.
Rex Stanworth (Q): And is there a charge, will there be a charge for the decontamination?
Larry Dalton (A): At Lake Powell they're charging about $50.00 an hour on their two units. Airamark, the concessionaire is manning those units. The Division of Wildlife

units, we will not charge a fee this year. That's not saying we won't next year. After we assess what it means in terms of workload, timing and the like, we may be charging a fee. In fact I think it will be pretty likely. At Lake Powell they have 100,000 launches a year. They decontaminated 500 boats last year. You play the math on that, that's one half of one percent of the boats. And that's kind of what I'm expecting to see on an average across the state of Utah. We'll see what works out.

Rex Stanworth (Q): I guess one of the questions I've got is if somebody goes, let's say goes to Strawberry and they're greeted at the dock, or at the area where they're going to launch their boat, and somebody walks up to them and says where have you used your boat and they say, well yeah we've used it there. Have you had your boat decontaminated? No. Is there any fear that those mussels could be moved from that launch area out into the water via either shoes, or tires, or whatever it might be coming through that lot? Is there any, I mean are you thinking of that being a problem at all?

Larry Dalton (A): Hypothetically, sure, any piece of equipment that is exposed to the water in an infested lake if brought to another water before it has dried or been decontaminated with scalding water has the potential to inoculate a new water. So hypothetically, yes. In reality it hasn't been documented to see movement occur in that way. Movement is pretty much occurring on or in your boat with either veligers, or juveniles, or adults attached to that equipment.

Rex Stanworth (Q): I guess my point was going to be that at least in most of those waters you've got areas where you have to check in, pay your fee to get in. Is that going to be an appropriate to ask this question rather than at the launch site?

Michael Fowlks (A): We're focusing on the highest threat. We're focusing on stopping that boat from launching before it gets in the water, that's the highest threat. I think Larry's right, I think there is some hypothetical chance you could get some contamination if they haven't already hit the water but certainly the biggest threat is when they put the boat in the water, or the trailer.

Rex Stanworth (Q): Now this form that you're going to have these boaters fill out, if I've got a boat but I've never left the state of Utah, if I put this in my window, the same form each time, is that going to be acceptable or is it going to have a new date on it every single time I go into the water?

Michael Fowlks (A): We'd like you to re-date it. And all you've got to do is say that you haven't been in infested waters and just re-date it when you launch.

Rex Stanworth (Q): Okay. My last question is the penalty. Just looking at this, it says there's a penalty under such and such. What is the penalty if somebody is caught putting a contaminated boat in the water?

Michael Fowlks (A): The penalty for a violation of the rule, the proposed rule, would be a Class C misdemeanor. A violation of the statute would be a Class B misdemeanor. And maybe Marty Bushman, our attorney would like to expound on that.

Marty Bushman, Assistant Attorney General assigned to Utah Division of Wildlife Resources (A): There will be a two-tier criminal violation system. If you are transporting these mussels in any type of conveyance in the state, having have been in an infested water without decontamination, this is what the Code says. But the legislature passed this last year, is if you are doing it knowingly and intentional, in other words you know you got mussels, you may have them encrusted on the prop or the hull of the boat and you're moving them across the state and you have not disinfected that's a Class A misdemeanor.

If on the other hand you've been in an infested water but you don't have necessarily direct knowledge that you've got them on board that is considered a Class, actually it's an infraction, which means it's equivalent of a Class C misdemeanor except you can't go to jail for an infraction. So the idea was is you're going to be held strictly liable if you've been in an infested water that you may have those on board but it will be an infraction unless you know you've got them, because you've visually seen them, and you're moving them across the state, then it ups it up to a Class A misdemeanor
Rex Stanworth (Q): Thank you.
Michael Fowlks (A): I should add that if you voluntarily comply with decontamination there is no penalty.
Jake Albrecht (Q): Say you get them into some type of waterway that moves water to a town, or a city, some canal, who pays for the cost?
Larry Dalton (A): You do. The facility controller, a water conservancy district, would suffer the cost at the front but you all know what happens when their maintenance costs go up; it will be passed on to the user. So what I said at the start, "you do", is pretty much the answer.
Jake Albrecht (Q): Is that somewhere in here (referring to the plan and/or the Rule)?
Larry Dalton (A): That's a reality of life. That's not in any rules or laws.

Questions From Public:
None.

Comments From Public:
None.

Comments, Discussion & Motions by RAC:
Jack Hill (Comment): I sure hope there's a lot of help from other state agencies.
Larry Dalton (A): We are seeking assistance from other state and federal agencies, and they are indicating an interest in helping.
Jack Hill (Comment): Coincidentally, two weeks ago I was in Las Vegas and there was an article that appeared in the Las Vegas Review Journal about the infestation of these mussels in the National Fish and Wildlife Services hatchery at Lake Mojave. And so it got me thinking about the infestation and I was driving back to Utah. And that's, it was just a run of the mill weekend and I counted, I don't drive very fast, about 65 miles an hour, so a lot of those great big trucks pulling those great big boats went by me and I counted 11. And I thought, holly Toledo. If there are 11 on a casual weekend I wonder what it's going to be like on the 4th of July or Labor Day and they start stopping those boats at the port of entry south of St. George. It would seem like to me that the DWR's going to have a hell of a problem relative to decontaminating those boats that have been on Lake Mojave or Lake Mead.

The AIS plan was an information topic, so no action was taken. But, Rule R657-60, Aquatic Invasive Species Interdiction was an action item; a motion was passed that it be recommended to the Wildlife Board as presented.

August 12, 2008 Filmore, UT: Douglass Messerly, Utah Division of Wildlife Resources Southern Region Supervisor and Southern RAC Secretary, called the meeting to order; there were 138 interested parties in attendance in addition to the Regional Advisory Council members, Wildlife Board members and Utah Division of Wildlife Resources employees.

Crystal Stock, Utah Division of Wildlife Resources' Southern Region AIS Biologist, presented the Utah Aquatic Invasive Species Management Plan as an action item using a brief PowerPoint presentation. The RAC was reminded that an in depth informational presentation of the draft plan had earlier been made, and that the plan was available for public review and comment at www.wildlife.utah.gov/invasivespecies/aisplan. Questions from the RAC and the public, RAC discussions, and answers from the presenter are included in this summary.

Questions From RAC:

Jack Hill (Q): You indicated that the water at a car wash is not hot enough. But if it's a pressurized washing process wouldn't that adequately serve to remove the mussel and or mud?

Crystal Stock (A): It would on the outside of your boat. The issue is that water gets up in your engines, which we can successfully clean with attachments that we have. So even before you leave the water it's going to suck up a little bit of extra water and it can live there. It's actually the best environment for them because they're not exposed to the sun or the heat, they don't dry out. Also, in your live wells and bilges we have special attachments for our machines also to actually flush those out and that's why we need the hot water.

Jack Hill (Q): Okay

Questions From Public:

John Krosher (Q): I've heard rumors that there's possibilities this is taking place in Lake Powell. Can you dispel those rumors or?

Crystal Stock (A): Lake Powell has been being tested for mussels. We do this thing called PCR analysis. And basically what happens is a net gets pulled through the water to capture little tiny microscopic things; plankton, which could include quagga mussel veligers. They did have one positive sample in August of '07 come up for quagga mussels, but there has not been another positive sample or a find of an adult population of mussels anywhere in Powell. We test every two weeks; so, right now we're saying they're not infected. So it's been almost a year now and we haven't found any other evidence anywhere. So what there is to say about that is that it's very possible that there was a mussel in Powell, maybe on a boat that they launched for the day and it spawned in the water and we happened to pick it up, we're hoping. But the most recent news is that Lake Granby in Colorado has been found with the veligers, which is a very young mussel, microscopic, they are a free-floating stage. If they end up getting an adult breeding population of mussels, which we have not seen in Lake Powell yet, it does feed into the Colorado River and it's possible that Lake Powell could get it. But we're still

waiting to find out if we have any actual live adult mussels in Lake Granby in Colorado. Does that answer your question?

Comments From Public:
None

Comments, Discussion & Motions by RAC:
Steve Dalton (Motion): He made a motion to accept the AIS Management Plan as presented, seconded by Dell LeFevre; passed unanimously!

Southeastern Regional Advisory Council (RAC)

The meeting agenda included multiple topics; comments, discussion and motions relative to the Utah Aquatic Invasive Species Management Plan follow:

May 28, 2008 Green River, UT: Vice Chair Terry Sanslow called the meeting to order; there were approximately 21 interested parties in attendance in addition to the Regional Advisory Council members, Wildlife Board members and Utah Division of Wildlife Resources employees.

Larry Dalton, Utah Division of Wildlife Resources'AIS Coordinator, presented the Utah Aquatic Invasive Species Management Plan as an informational item using PowerPoint. The plan's Executive Summary was provided and the RAC was advised that the plan would be briefly presented again in August, seeking approval. Additionally, Utah Division of Wildlife Resources Law Enforcement Chief, Mike Fowlks, followed Larry Dalton, and presented Rule R657-60, Aquatic Invasive Species Interdiction as a PowerPoint for approval action (it passed unanimously). Questions from the RAC and the public, RAC discussions, and answers from both presenters relate directly to the AIS management plan, so both are included in this summary.

Questions From RAC:

James Gilson (Q): He advanced a hypothetical situation about boating at Lake Powell, followed by a launch at Scofield Reservoir; how would that be treated?
Larry Dalton (A): A boat that had been at Lake Powell would not be subject to decontamination, since Lake Powell has not been declared a contaminated water. If Lake Powell were declared contaminated at a future time, then decontamination would have to occur before launching at Scofield Reservoir.
Terry Sanslow (Q): What are examples of the term, "conveyance" in the Rule?
John Pratt (A):The term could include waders, float tube, paddle boats, equipment, tools, anchors, buoys and all types of water craft.
James Gilson (Q): What is the Division's right to close a water body?
John Pratt (A): Affirmed that we could; If a water body were closed, a boat would have to be decontaminated before leaving the area.
Laura Kamala (Q): Can quagga mussels be eradicated from a contaminated water body?
John Pratt (A): Eradication may be possible with rotenone or potassium chloride, or if the water body were drained and dried or drained and completely frozen.
Larry Dalton (A): Cost for chemical treatment is very expensive; probably prohibitive.
Walt Maldonado (Q): What about staffing at launch locations?
Larry Dalton (A): DWR has only limited staffing at major launch sites for a single shift a day. Partnerships with other agencies will augment the monitoring program.
Drew Sitterud (Q): What about the preferred substrate for mussel attachment; what is it?
Larry Dalton (A): Quaggas prefer a hard or calcium-rich surfaces. PVC pipe, concrete, cinder block, boat hulls, and plastic are commonly used as attachment substrates.

Questions From Public:

Public (Q): How do you decontaminate bladder boats?

Larry Dalton (A): The self-decontamination process is recommended; but the professional method with scalding water will do the trick. Caustic chemicals, such as bleach or potassium chloride, could damage bladders and other sensitive equipment.
Public (Q): What is the cost for professional decontamination?
Larry Dalton (A): A professional decontamination employs scalding hot water. At Lake Powell, the marina operator charges $50 per hour. This year, the DWR will perform this service free-of-charge.
Public (Q): I worry about boaters self-certifying.
Larry Dalton (A): Me too, I share that the concern, but boaters have a vested interest in the resource, and have shown extraordinary commitment in other states, where self-certification has been used.
David Lacey (Q): Are there natural predators that could control the quagga mussel?
Larry Dalton: Yes; there are natural predators within its native geographical range in Russia that are able to control the species, but we lack those same natural controls.
Bill Love (Q): Ken's Lake Water Master asked me about monitoring this water for mussel presence.
Larry Dalton (A): The likelihood of contamination is small for Ken's Lake, but monitoring measures that are being developed and decontamination protocols will be shared, so they could do it themselves.

Comments From Public:
None.

Comments, Discussion & Motions by RAC:
Walt Maldonado (comment): He congratulated the state for its aggressive action to stem the advance of aquatic nuisance species. As a Bass Federation representative, Walt volunteered the assistance of his organization in the effort to stem the advance of these mussels.
Larry Dalton (A): Identified that progress has been made in educating the public, and welcomed the partnership of the Bass Federation.

The AIS plan was an information topic, so no action was taken.

Rule R657-60, Aquatic Invasive Species Interdiction was an action item; a motion was passed that it be recommended to the Wildlife Board as presented.

August 13, 2008 Green River, UT: Vice Chair Terry Sanslow called the meeting to order; there were 22 interested parties in attendance in addition to the Regional Advisory Council members, Wildlife Board members and Utah Division of Wildlife Resources employees.

Paul Birdsey, Utah Division of Wildlife Resources' Southeastern Region Aquatic Program Manager, presented the Utah Aquatic Invasive Species Management Plan as an action item using a brief PowerPoint presentation. The RAC was reminded that an in depth informational presentation of the draft plan had earlier been made, and that the plan was available for public review and comment at www.wildlife.utah.gov/invasivespecies/aisplan. Questions from the RAC and the public, RAC discussions, and answers from the presenter are included in this summary.

Questions From RAC:
Walt Maldonado (Q): He asked if quagga mussels had been found in Lake Powell.
Paul Birdsey (A): He replied that Lake Powell was still considered free of the quagga mussels, but that status could change in the near future. A Colorado reservoir, draining into the Colorado River, was found to be infested with quagga mussels. Paul indicated that it would only be a short time, before quaggas were washed into Lake Powell.

Questions From Public:
None.

Comments From Public:
None.

Comments, Discussion & Motions by RAC:
Walt Maldonado (Comment): Walt advised Paul Birdsey that he had been to Hite yesterday. Walt had seen only a few AIS pamphlets, and was alarmed to discover an absence of AIS clearance forms. This represented a serious breech of security for the Lake.
Paul Birdsey (A): He explained that Wayne Gustaveson was in charge of managing all launch areas on the Lake, and was apparently unable to keep up with interdiction demands. Paul said he would contact Wayne and advise him of the security breech.
Pam Riddle (Motion): She presented a motion to approve the AIS Management Plan as presented, which was seconded by Walt Maldonado; it passed unanimously.

Northeastern Regional Advisory Council (RAC)

The meeting agenda included multiple topics; comments, discussion and motions relative to the Utah Aquatic Invasive Species Management Plan follow:

May 29, 2008 Vernal, UT: Chair Amy Torres called the meeting to order; there were 25 interested parties in attendance in addition to the Regional Advisory Council members, Wildlife Board members and Utah Division of Wildlife Resources employees.

Larry Dalton, Utah Division of Wildlife Resources'AIS Coordinator, presented the Utah Aquatic Invasive Species Management Plan as an informational item using PowerPoint. The plan's Executive Summary was provided and the RAC was advised that the plan would be briefly presented again in August, seeking approval. Additionally, Utah Division of Wildlife Resources Law Enforcement Chief, Mike Fowlks, followed Larry Dalton, and presented Rule R657-60, Aquatic Invasive Species Interdiction as a PowerPoint for approval action (it passed unanimously). Questions from the RAC and the public, RAC discussions, and answers from both presenters relate directly to the AIS management plan, so both are included in this summary.

Questions From RAC:

Rod Harrison (Q): Will water from a local car wash kill these mussels on a boat?
Larry Dalton (A): You can't get 140 degree water from a car wash nor from your water heater at home. UDWR is providing cleaning stations which produce 165 degree F. water so that when it is 8 to 10 inches from the wand, the water temperature will be 140.

Questions From Public:

Robert Judd (Q): I'd like to know more about the professional decontamination stations.
Mike Fowlks (A): There will be professional decontamination stations and will be taken care of to ensure excess water is not put aback into the waters.
Robert Judd (Q): Are there any guidelines so they know what they would have to have for decontamination:
Mike Fowlks (A): The only ones are UDWR stations now.
Robert Judd (Q): What if I wanted to start my own business?
Larry Dalton (A): We haven't written guidelines yet. They will be forthcoming. We've been contacted by a few entrepreneurial souls who want to make money. I am happy because I believe private enterprise in the State of Utah can make some money and serve our constituents. Lake Powell has 100,000 launches in a year and they decontaminated 500 boats last year. That's ½ of 1% of the boats required decontamination. This year we may find that at some locals we will want to build catchment stations and real drain fields. At Lake Powell with two stations doing 500 boats, there's a pad that captures the water, cleanses it and reuses it on the next boat. We'll be doing boats at 26 locals with portable stations.
The guidelines will give you a list of vendors and guidelines for water temperatures, etc.
Karl Breitenbach (Q): We use a lot of Clorox in the medical profession. Would that work?
Michal Fowlks (A): According to the rule that we're proposing, the only two decontaminations we will accept are "clean, drain and dry" or 140 degree water. We're not authorized for anything else at this point.
Larry Dalton (A): There are other methodologies that will kill them like potassium chloride at 100 parts per million. But the contact time is 12 hours. And you can't hold a rag on your boat

for 12 hours. All of the other methods are caustic and not as effective. They are not immediate, so we're not going to pursue them at this time.

Comments From Public:
None

Comments, Discussion & Motions by RAC:
Kevin Christopherson (Comment): It starts to sound like the sky is falling, but it's more than a fishing issue. You can imagine your irrigation line being impacted. It's a new world and when we start telling boaters they have to wash their boats and not just for a year but forever. We really need the public's support. I'd like to introduce Natalie Muth as our regional aquatic invasive species biologist. She's doing a really great job.
Carlos Reed (Comment): We went to a summit meeting at the UDWR office in SLC and we discussed the Quagga mussel issue and the Endangered Species Act. I got hold of Larry who set up some training for Tribal waters like Midview and Bottle Hollow and Natalie Muth has come over and trained us. We have these certification self-inspection forms at the Ute Plaza and these forms need to be filled out first before you're even able to pick up a permit from the Tribe. The Tribe was presented a program from Natalie yesterday and passed a resolution and that we will help with enforcement from the Tribe side too. We want to let the public know that we will be enforcing this on Tribal waters, and thanks to the Division for the training

The AIS plan was an information topic, so no action was taken.

Rule R657-60, Aquatic Invasive Species Interdiction was an action item; a motion was passed that it be recommended to the Wildlife Board as presented.

August 14, 2008 Vernal, UT: Chair Amy Torres called the meeting to order; there were 12 interested parties in attendance in addition to the Regional Advisory Council members, Wildlife Board members and Utah Division of Wildlife Resources employees.

Roger Schneidervin, Utah Division of Wildlife Resources' Northeastern Region Aquatic Program Manager, presented the Utah Aquatic Invasive Species Management Plan as an action item using a brief PowerPoint presentation. The RAC was reminded that an in depth informational presentation of the draft plan had earlier been made, and that the plan was available for public review and comment at www.wildlife.utah.gov/invasivespecies/aisplan. Questions from the RAC and the public, RAC discussions, and answers from the presenter are included in this summary.

Questions From RAC:
Kirk Woodward (Q): What is their life cycle?
Kevin Christopherson, Utah Division of Wildlife Resources' Northeastern Regional Supervior and Northeastern RAC Executive Secretary (A): They are very adaptive and very aggressive. They have a free swimming stage called veligers, they release them by the millions per mussel. Some of those veligers will turn into adults the same year and some take two years. They are like seeds to the wind. In Lake Mead, it took many years before we found them, and so you're always playing catch up. We know what mesh size

to use now to collect them and the best time of year to sample. Samples have been taken at Flaming Gorge last year, and we'll have do more tests this year. In Lake Mead, once they found them, the population just exploded exponentially.
Kirk Woodward (Q): Is there any natural predator?
Roger Schneidervin (A): In Europe there is a fish that can crack them but some mussels have a shell that closes so they pass right through the fish's digestive system without being affected.

Questions From Public:
Ryan Kramer (Q): Are they doing something for internal boats as far as making sure they've been drained?
Roger Schneidervin (A): If your boat's been to one of these lakes there will be some follow up. We are looking into chemical solutions to be poured into the coolant. Some boats have separate air conditioning water units. It's kind of an evolving process and we're trying to keep a step ahead of it. There have been good ideas that have come from boaters and technicians.
Russell Lee (Q): With our cold winters, does that help kill them? And, where did they come from?
Roger Schneidervin (A): If the boats dry for several weeks the quagga will become desiccated. In winter they'll freeze. If they're moist though, they can last a long time. We're encouraging boaters to clean, drain and dry their boats and any other equipment that touches the water. Specifically, "clean" plants, fish, mussels and mud from your boat; "drain" the water from all areas of your boat and equipment; and "dry" your boat and equipment in the sun before using it again. In the summer, let it dry for at least 7 days in the sun. In the spring and fall, dry it for 18 days in the sun. In the winter, leave your equipment out for 3 straight days in temperatures that do not rise above 32 degrees during any of the days. Leaving it out for 3 days should be enough to kill any mussels that are on your equipment.

Roger Schneidervin (A): They came from Europe into the Great Lakes and Erie Canal through bilge water.
Roger Schneidervin (A): New Zealand mud snails, another AIS, have moved around rapidly, too. They can stick into the felt of waders and can last for weeks in the damp foot, and they're asexual so they can multiply. Although, we haven't seen the negative impact to fisheries with the mud snail that we were worried about.
Ron Stewart (Q): If mussels are in a reservoir, are they going to survive winter?
Kevin Christopherson (A): They're flourishing in Lake Michigan which freezes-over in winter.
Tyson Kramer (Q): Are there any universities doing studies?
Roger Schneidervin (A): There are several universities working on it. UDWR's Fishery Experiment Station is coordinating with Utah State University's Fish and Wildlife Department on possible ongoing research comparing various early detection methodologies.
Tyson Kramer (Q): What does it do to the fish habitat?

Roger Schneidervin (A): It does a lot of harm. They filter a huge volume of water per day, like a quart per quagga mussel. They take all the algae out of the water. Some mussels attach to shallow water, others go deep.

Comments From Public:
None.

Comments, Discussion & Motions by RAC:
Kevin Christopherson (Comment): I just met with Colorado and their state gave them 3.1 million dollars to protect water pipes, intakes, etc. It was a unanimous vote. On major reservoirs in Colorado, the BOR is threatening to shut waters to boaters now, before the problem happens if agencies can't prove they are taking effective measures to control mussels in order to protect power generators, etc. In Utah we will fail without continued public support because with current funding ($1.4 million General Funds per year) we're probably only getting 40% coverage for recreation hours of use on our major lakes. We need more funds.
Roger Schneidervin (Comment): Our farmers only use 2" and 4" irrigation lines, while some of the other pipes in industry are huge, but are being clogged. I don't see how we could deal with it and keep raising hay and irrigating crops if the mussels get into our waters.
Karl Breitenbach (Motion): He presented a motion to approve the AIS Management Plan as presented; it was seconded by Kirk Woodward; passed unanimously!

Central Regional Advisory Council (RAC)

The meeting agenda included multiple topics; comments, discussion and motions relative to the Utah Aquatic Invasive Species Management Plan follow:

June 3, 2008 Springville, UT: Chair Ed Kent called the meeting to order; there were 593 interested parties in attendance in addition to the Regional Advisory Council members, Wildlife Board members and Utah Division of Wildlife Resources employees.

John Fairchild, Utah Division of Wildlife Resources Central Region Supervisor, briefed the meeting attendees indicating that all seasonal technician positions were filled to carry out the AIS program in the region. So, boaters should expect to be checked at boat ramps by the technicians inspecting their boats in order to avoid the spread of invasive quagga and zebra mussels.

Larry Dalton, Utah Division of Wildlife Resources'AIS Coordinator, presented the Utah Aquatic Invasive Species Management Plan as an informational item using PowerPoint. The plan's Executive Summary was provided and the RAC was advised that the plan would be briefly presented again in August, seeking approval. Additionally, Utah Division of Wildlife Resources Law Enforcement Chief, Mike Fowlks, followed Larry Dalton, and presented Rule R657-60, Aquatic Invasive Species Interdiction as a PowerPoint for approval action (it passed unanimously). Questions from the RAC and the public, RAC discussions, and answers from both presenters relate directly to the AIS management plan, so both are included in this summary.

Questions From RAC:

Byron Gunderson (Q): If invasive species are discovered in a reservoir somewhere how do you intend to contain that species?
Larry Dalton (A): Mike Fowlks will talk about the law enforcement aspect of that. We will be controlling people being able to go to or leave such a reservoir. The operator of such a reservoir would have to develop a plan that is approved by the Division of Wildlife. Mike will talk more about that.
Ed Kent (Q): Has the memorandum been adopted yet between you and UDOT, regarding ports of entry?
Mike Fowlks (A): No, it has not. We have initiated contacts with UDOT but we want to get the rule in place so we address all the issues.
Ed Kent (Q): Have you identified any times and locations you may be working with UDOT at ports? I assume the main location would be in St. George.
Mike Fowlks (A): That will be the most important one. The southern region has looked at when the most effective times will be.
Byron Gunderson (Q): Draining seems fairly straight forward but if you just dump your bilge into the storm water system you are actually propagating the spread of these species. Would there be a Clorox or other chemical you could put in the water before you drain it?
Mike Fowlks(A): There are chemicals that will kill these critters. They are expensive in the concentrations you need. We are not going to approve those as official decontamination. What you need to remember is if you are in infested waters you need to clean and drain prior to leaving, then dry for the appropriate amount of time as Larry identified.

Questions From Public:
Todd Carter (Q): If we know Lake Mead is a problem could we call a special legislative session and pass into law that boats have to stop at the port of entry to be cleaned? It would be easier to stop them there than at every reservoir in the state.
Larry Dalton (A): Again I don't want to steal Mikes thunder but in fact we will be dealing with ports of entry and the law will allow us the ability to work there.

Comments From Public:
None.

Comments, Discussion & Motions by RAC:
The AIS plan was an information topic, so no action was taken. But, Rule R657-60, Aquatic Invasive Species Interdiction was an action item; a motion was passed that it be recommended to the Wildlife Board as presented.

August 14, 2008 Springville, UT: Chair Ed Kent called the meeting to order; there were 200 interested parties in attendance in addition to the Regional Advisory Council members, Wildlife Board members and Utah Division of Wildlife Resources employees.

Evan Freeman, Utah Division of Wildlife Resources' Central Region AIS Biologist, presented the Utah Aquatic Invasive Species Management Plan as an action item using a brief PowerPoint presentation. The RAC was reminded that an in depth informational presentation of the draft plan had earlier been made, and that the plan was available for public review and comment at www.wildlife.utah.gov/invasivespecies/aisplan. Questions from the RAC and the public, RAC discussions, and answers from the presenter are included in this summary.

Questions From RAC:
Byron Gunderson (Q): Is the 140 degree decontamination procedure free?
Evan Freeman (A): That is free with our state owned units. There currently is a charge if you go to Lake Powell, however, we have been working with them to eliminate that cost.

Questions From Public:

Matt Madsen (Q): Is there anything being done as far as phragmite control at Utah Lake?
Evan Freeman (A): I am not aware of that.
John Fairchild—Utah Division of Wildlife Resources Central Region Supervior (A): There is currently no project planned on Utah Lake but the Utah Lake Commission will be looking at different things that impact the June sucker and this would be one of them.
Matt Madsen (Q): How much will the lack of federal intervention impact our ability to keep these out of our waters? We have them in Colorado, Nevada and Arizona and the feds are basically doing nothing.
Evan Freeman (A): This is one of the first steps to actually getting some money from the federal government. Once we get our state plan approved then we take it to the national invasive species committee. Once that is approved then there is some money that can be directed toward the state. Also, we are also working very closely with the park service at Lake Powell.

Matt Madsen (Q): People fish in Colorado and then come over and fish in the basin and no one is checking as they come into the state. We have the same problem with Lake Mead. I know we are limited. Is the four day work week going to affect that too?
Evan Freeman (A): One of our problems is man power. We are working to address that in the future because we are limited. We are working with UDOT to try to get some cooperative agreements to work port of entries. That is still in the works.
Matt Madsen (Q): Is the legislature going to give you money for this?
Ed Kent—RAC Chair (A): They appropriated 1.4 million dollars this session for the program.
Evan Freeman (A): The legislature gave us 1.1 million dollars for fiscal year 08 and then ongoing 1.4 million building blocks.

Steven Close (Q): As a dedicated hunter I spent a day doing surveys at the American Fork boat harbor. I look at the overall problem and feel like we aren't really extending very much resource to get a handle on this. I would like some clarification about the program. You talked about the checking stations conducting surveys but when will that happen?
Evan Freeman (A): That would be our personnel working at the port of entry station. The timeframe is up to people higher up than I am.
Steven Close (Q): Why would it be the fish and game personnel to require boats to show validation? Most boats that have been checked are fine to drive through. It's the holes and gaps and people who haven't been checked that require the education.
Evan Freeman (Q): We have an outreach strategy through the media trying to get the knowledge out. We have had a good response from most of the public. We get calls asking us to come and decontaminate their boats instead of us having to stop them at the gates.
Kyle Dodge (Q): Have predators of these invasive species been discovered?
Evan Freeman (A): We don't have any natural control methods in the United States that would limit the population or decrease the population.
Kyle Dodge (Q): But they came from another country.
Evan Freeman (A): Correct, their original range was the Eurasia. The Black Sea, the Caspian Sea. There are natural controls in that area.
Kyle Dodge (Q): Is the Division considering introducing exotic predators?
Evan Freeman (A): Not at all, that would just compound one problem with another. The perfect example of that is one of the native predators around Gobi was accidentally introduced into the great lakes region. While they do feed on muscles they are finding it a lot easier to feed on the salmonid eggs and walleye eggs.
Kyle Dodge (Q): Do you anticipate the professional cleaning having a cost in the future?
Evan Freeman (A): We are assessing that right now. We don't plan on a cost. We get a lot more cooperation if we are providing it at no cost.

Comments From Public:
None.
Comments, Discussion & Motions by RAC:
Richard Hansen (Q): Seeing how this isn't just a fisherman problem are you receiving any money from the State?

Ed Kent—RAC Chair (A): 1.4 million dollars was appropriated of general fund money.
Fred Oswald (Motion): I move to approve plan as presented
Gary Nielson (Motion): I seconded.
Note: Motion passed unanimously!

Northern Regional Advisory Council (RAC)

The meeting agenda included multiple topics; comments, discussion and motions relative to the Utah Aquatic Invasive Species Management Plan follow:

Larry Dalton, Utah Division of Wildlife Resources'AIS Coordinator, presented the Utah Aquatic Invasive Species Management Plan as an informational item using PowerPoint. The plan's Executive Summary was provided and the RAC was advised that the plan would be briefly presented again in August, seeking approval. Additionally, Utah Division of Wildlife Resources Law Enforcement Captain, John Pratt, followed Larry Dalton, and presented Rule R657-60, Aquatic Invasive Species Interdiction as a PowerPoint for approval action (it passed unanimously). Questions from the RAC and the public, RAC discussions, and answers from both presenters relate directly to the AIS management plan, so both are included in this summary.

May 29, 2008 Brigham City, UT: Chair Brad Slater called the meeting to order; there were 151 interested parties in attendance in addition to the Regional Advisory Council members, Wildlife Board members and Utah Division of Wildlife Resources employees.

Questions From RAC:

Dennis Shirley (Q): Is there any biological control internationally that might be able to be placed in the water.
Larry Dalton (A): The State of Minnesota has had this problem for 20 years. We are launching a campaign like they have. They have held the mussels at bay for 20 years; at least holding them to the original 4 lakes and the Mississippi River that were originally infested.
Dennis Shirley (Q): Are there some biological control methods?
Larry Dalton (A): A researcher has been working with a bacteria called psuetonomous. If we swept this floor and cultured the dust, we would find psuetonomous. It kills the mussel pretty good but not 100%. They just received a grant to go commercial with it. We think it will be available in 2010, but have no idea what the cost will be.
Foutz (Q): Are new boat owners who are purchasing boats getting this information at the time of sale?
Larry Dalton (A): I think so. The coast guard has given us a hand in distributing the Zap the Zebra brochures. And, the table topper display has been placed all over the state of Utah. The next step is to deliver a maintenance message to boat shops about how to deal with this issue. Other states will pitch in and give us a hand with boat repair shops.
Ann Neville (Q): I have a question on bringing a boat from Lake Mead or whatever and they go to the local car wash and spray it down. That is not decontaminating but will the mussels go down storm drains.
John Pratt (A): Yes they will and they will live for 30 days.
Ann Neville (Q): So there is there any plan to address those types of cleaning?
John Pratt (A): The car washes are not 140 degrees so it is not decontamination.
Ann Neville (Q): That is what I mean. They are going to get into the storm drains.
John Pratt (A): Yes. Larry can probably address that. Its not against the law to prevent people from washing at car washes, but that will not kill the quagga mussels, since its not hot enough.
Larry Dalton (A): The sand filters at the car wash, as the water leaves and enters the sewage system, will likely hold them back, but the treatment at the downstream water reclamation plant will not likely kill them.

Ann Neville (Q): No chemicals will kill them on your boat?
John Pratt (A): There are 2 chemicals on the market. Potassium Chloride and Chlorine. Both require an extended period of contact time—up to 7 days.
Ann Neville (Q): They won't desiccate in 7 days?
John Pratt (A): Depending; summer time hot and dry are bad on mussels. Cold, cool or damp are good for them. The law defines the drying time by a month.
Ann Neville (comment): I am just trying to help us and help people figure out how to clean their boats.
Gaskill (Q): What is the penalty?
John Pratt (A) Class B misdemeanor. Knowing you are intentionally possessing mussels makes it a class A.
Gaskill (Q): Do you think it ought to be capital? [humor]
John Pratt (A) No, I think that every water user ought to be able to take their licks on him. [more humor]
Cowley (Q): I find myself a little concerned over the closure order on water bodies. I am wondering if you can walk me through that. Let's say we detect them at Pineview Reservoir.
John Pratt (A): First of all, Larry Shaw [conservation officer] will have to identify what is there. We have to be 100% certain.
Cowley (Q): I was looking at the number of campground hosts and boat launch hosts; not enough to catch every boater before they launch or leave.
John Pratt (A): Once we make the decision a water is infested, and the director has the closure order, in consultation with the management agency--that would be the forest service and Pineview water users and bureau of reclamation--there would probably be 3 involved in that. We would go through the order and decide on a control/containment plan. We need to stop immediately any boat movement that would spread that mussel.
Cowley (Q): That is why I am wondering if you are going to have 100 boats sitting on the reservoir that are not being allowed to pull out of the docks.
John Pratt (A): They would not be allowed to leave, unless they decontaminate. So what we would do is start scrambling and if they guy wants to bring his boat out, he gets decontaminated on his way out and does not go back in.
Cowley (Q): As we try to keep these mussels out of the state of Utah, I wonder why you wouldn't just have your limited decontamination units at your port of entry and then at Lake Powell and do a decontamination as boats leave those facilities instead of trying to find them while coming in to each water.
John Pratt (A): That is why port of entries were in the rule. We need to be moving in that direction.
Cowley (Q): That would be all of your drinking water facilities or irrigation facilities would be shut down at that point.
John Pratt (A): We are asking for a plan to control that boat traffic. I could not shut Pineview water treatment plant off.
Cowley (Q): That would not be a physical feature conveyance.
John Pratt (A): The water treatment plant is not a conveyance. But, the plan needs to address all of those.
Larry Dalton (A): You asked a question as to why we are not using ports all the time? We will work ports of entries when times are best. We will be working launch sites, too; they are good everyday. We do not have enough resources to work ports or launch sites 24/7. We can be there 5 days a week, one shift a day. We will do the best we can. We are setting up a scheme of a double shield by working ports & launch sites. There are several things in play here to shield the state of Utah from these mussels—interdictions, outreach, enforcement.

Cowley (Q): On the Forest Service side we are picking up funds to help increase that shield, especially at the high use lakes.
Larry Dalton (A): We appreciate that help. We understand there are 3 decontamination units.
Ann Neville (Q): In the rule it does not say under the closure part of it, it says that the controlling entity would be bringing in or taking out. It does not say that anything can be removed, so that is implicit what you said as far as if they are decontaminated, they can leave?
John Pratt (A): Where are you at? [reading in the proposed rule]
Ann Neville (Q): I am on 60-8, closure order for water body facility or water supply.
John Pratt (A): It includes decontamination.
Ann Neville (Q): Ok, do we assume that it is implicit or do we need to modify that so that it is very clear to a boat owner who is on Pineview that they can leave if their boat is decontaminated?
John Pratt (A): I am almost certain that it is here in the rule; I am just going to find it for you.
Ann Neville (Q): I want to make sure that the boat owners understand what they can and can't do.
Cowley (Q): I believe that the rule is very clear to that?
Walt Donaldson, Utah Division of Wildlife Resources' Chief of Fisheries (A): What we will do is take that information as we move forward and present that to the board. If you give us some time to look at that. What we ask the RAC tonight is to generally approve the concept with the condition that we look to make sure that is not implicit and that it is clear before it goes before the board for their action. Would that be helpful?
Ann Neville (Q): Yes, I just feel it would be better for the public to know what they are getting into.
Walt Donaldson (A): That would be appropriate.
Cowley (Q): As I look at this rule, if we look back under the definitions it may be semi-covered there where we are saying a conveyance refers to a vehicle or vehicle parts that may carry or contain. If it is decontaminated, it no longer carries or may contain the mussel. It would be better if it was spelled out in the closure.

Questions From Public:
John Staley (Q): The first question on your self-certification form asks if in the last 30 days, has your boat been used in Lake Powell, outside of Utah or in any of the following waters? How do I answer that question?
Pratt (A): Have you been in one of these waters? Either, Yes or No.
John Staley (Q): It says outside of Utah; I fish on the Wyoming side of Flaming Gorge.
John Pratt (A): OK, you are going to say yes--I have been to Flaming Gorge in Wyoming. We are going to look and say "no problem". This is a definitive assessment of where you have been.
Myron Porter (Q): If I understand you, you are targeting boats. What about the pontoons, kayaks, canoes and waders? If I use a float tube in Lake Powell, must I wait 18 days in May before I fish in Mantua, etc.? If you just inspect the boats, you are not going to catch it right? Does the law already apply to those other things?
John Pratt (A): You have to go back to the definition of conveyance; we will inspect those other things, since they could carry quagga mussels.
Myron Porter (Q): Cooler water, if you put lake water in it, is it a conveyance you would inspect?

John Pratt (A): Yes. The biggest threat to the state of Utah comes from a mussel attached to a boat. Just good healthy boating habits--Clean, Drain & Dry--will get you by.

Comments From Public:
None.

Comments, Discussion & Motions by RAC:
Ann Neville (Comment): I appreciate the Division's aggressiveness on this.
Ron Hodson, Utah Division of Wildlife Resources' Northern Region Supervisor and Northern Region RAC Executive Secretary (Survey): He conducted an informal poll with the 151 members of the audience whether or not they had heard about the quagga mussel prior to the RAC meeting presentation. About 15% had not; about 40% had heard enough to know there was a problem and that they needed to do something to clean their boats; about 45% had heard a lot about the problem and understood what to do with their boats in terms of decontamination.

The AIS plan was an information topic, so no action was taken.

Rule R657-60, Aquatic Invasive Species Interdiction was an action item; a motion was passed that it be recommended to the Wildlife Board as presented, with modification to make it more clear as per Ann Neville's questions; passed unanimously!

August 20, 2008 Brigham City, UT: Chair Brad Slater called the meeting to order; there were 40 interested parties in attendance in addition to the Regional Advisory Council members, Wildlife Board members and Utah Division of Wildlife Resources employees.

Craig Schaugaard, Utah Division of Wildlife Resources' Northern Region Aquatic Program Manager, presented the Utah Aquatic Invasive Species Management Plan as an action item using a brief PowerPoint presentation. The RAC was reminded that an in depth informational presentation of the draft plan had earlier been made, and that the plan was available for public review and comment at www.wildlife.utah.gov/invasivespecies/aisplan. Questions from the RAC and the public, RAC discussions, and answers from the presenter are included in this summary.

Questions From RAC:
None.
Questions From Public:
None.
Comments From Public:
None.
Comments, Discussion & Motions by RAC:
Gaskill (Motion): I Move to accept the division's proposal as presented.
Byrnes (Motion):I second.
Note: The motion carried unanimously!

Utah Wildlife Board

The meeting agendas included multiple topics; comments, discussion and motions relative to the Utah Aquatic Invasive Species Management Plan follow:

June 19, 2008 Salt Lake City, UT: Chair Paul Niemeyer called the meeting to order; there were 5 interested parties in attendance in addition to the Utah Wildlife Board members, RAC Chairs or their designees, and Utah Division of Wildlife Resources employees. A draft Utah Aquatic Invasive Species Management Plan was presented as an information item and Rule R657-60, Aquatic Invasive Species Interdiction, was presented for action. Board minutes are as follows:

Larry Dalton, AIS (Aquatics Invasive Species) Coordinator presented this agenda item using a PowerPoint presentation. He said that relative to AIS, "we are going to work forever to keep them out, or work forever to get rid of them." Keeping them out is the smartest and the cheapest option. AIS are non-native and their population expands uncontrollably. They always cause ecologic and economic harm. There is quite a list that is threatening Utah and it is always changing. We have several of the fungus and algae that are affecting some of our waters and quite a list of plants. We have been dealing with these problems for years. The New Zealand Mud snail seems to be moving through irrigation systems and is transported on fishermen's felt boots. There are also several mussels that are causing problems in our area. We also have non-native fish, amphibians, and reptiles in our habitats. There are other issues that are threatening Utah from an aquatic invasive species issues including aquarium discards. Aquascaping also adds to these problems. Bait releases are also adding to the problem. We have so many pathogens around these days, and we are seeing diseased baits. On aquaculture, the state's Fish Health Board inspects for pathogens, inspecting state, federal and private hatcheries. There are many ongoing actions in Utah working to protect native habitat and species.

A new policy was created last year to prevent the invasion of *Driessena* mussels into Utah. This is a Utah Department of Natural Resource Policy and it identified the Utah Division of Wildlife Resources as the state's lead agency. We have hosted numerous interagency meetings within and outside of Utah. We are recognized as the lead agency on this issue in the West. We are setting precedent every week and the various states call seeing how we are dealing with this issue. We have launched a quagga education and implementation plan and outreach is the main focus of it, trying to teach Utah's public about how we can fight this invasive species.

We are interdicting and decontaminating watercraft all across the state of Utah. We will be looking at containment issues if we actually get the quagga mussels in Utah and certainly we have many invasive species here already. We are developing new laws and training personnel about how to deal with aquatic invasive species. We put a multi-agency Utah AIS Task Force in place this year to prepare the plan being presented today. In November we will be presenting the plan in Washington D.C. and after that the Utah Division of Wildlife Resources should be able to garner $40,000 from the U.S. Fish and Wildlife Service as support to states that have an approved plan. The plan's purpose is to

develop and document a program to be implemented for aquatic invasive species management within Utah. The goal is to keep AIS out or contain where we already have them.

There are several objectives in the plan. The Outreach objective is three fold: media, public education (adult boat owners) and next generation education (secondary & university students). The plan's decontamination objectives are interdiction (pre-launch boats), do-it-yourself decontamination (Clean, Drain & Dry), and professional decontamination (wash & flush with 140 degree F scalding water).

Mr. Dalton went on to discuss the management objectives of the plan, the plan targets *Dreissena* mussels, where they have come from, how the mussels move and the specific waters that are presently at risk to Utah. (See PowerPoint presentation for details) He went over the economic impacts of these mussels from a maintenance perspective and recreational expenditure perspective.

Utah Division of Wildlife Resources' team was funded at the last legislative session at about 1.4 million dollars a year. That is ongoing general fund money. We have a biologist over this specifically in every region and have put 35 wildlife technicians on our boat ramps across the state inspecting boats. We are going to add five conservation officers to our current staff. This program is going to cause more work for our officers.

The Zap the Zebra Brochures were mailed to 65,000 boat owners. As you enter Utah's parks and boating waters there are signs indicating that you have to self-certify as mussel clean before you launch. We have put 3,000 smaller versions around the boat launching areas. We have put 9,000 posters out that have this information on them. Self-certification is the cornerstone of this program. Every boater must self-certify, before launching, that his boat is mussel free. We have put 200,000 of these certifications on the ground and we are starting to see a day where we will run out of them. We will continue to make these signs, posters, billboards and certifications through the years. This management plan will be brought to the Board for approval in late August, but this is a working document. This concluded the presentation.

Mr. Woodard [board member] said the small watercraft need to be mentioned in the plan.

Mr. Dalton said they are including these in the plan. The jet skis are quite a challenge and they are becoming aware of new problems all the time.

Mr. Howard [board member] asked if there is any chemical that we could put in the ballasts of the boat.

Mr. Dalton said there is, potassium chloride, it will kill them at about 100 parts per million. This would be safe for the resource, but the contact time is 48 hours, so you cannot do the outside of a boat for this length of time. We are injecting potassium chloride into the ballast tanks. The owner helps us understand how much water is retained in the ballasts. If they have come from a infested water, we may have to

quarantine them for 48 hours, but have not run into this situation yet. Chorine works as well, but does not do a 100% kill. We are looking at a new product called Rydlyme that can be sprayed on the mussel. It immediately begins to dissolve the shell and we are experimenting with it. The National Parks do not want chemicals used that have not been tested.

Mr. Brady said at Lake Powell, a lot of people launch and retreive their boat daily. Do they have to have a new card every time?

Mr. Dalton said Lake Powell was a very suspicious spot when we started down this path. Last August we found veligers for *Dreissena* mussels in Lake Powell. We have sampled a lot since and not found them. What we do not know is if the mussels we found are definite, since only one of the three labs tested positive for them. At the time that we printed the first 100,000 pamphlets, Lake Powell was a very suspicious spot. We do not believe Lake Powell is an issue at this point, but will keep close watch with its proximity to Lake Mead.

Director Karpowitz said that Mr. Dalton and the rest of the aquatics staff should really be complimented on how fast they got this program in place. We really are a leader in the west and other states are modeling what we are doing. Mr. Dalton has become a leading expert in the west on this subject. This is a great service for the state of Utah, not only for fishermen, but everybody who uses water. All of us will be impacted if we cannot stop this. Our crew should really be thanked for giving it a great effort for prevention. This effort was put on people who already had a lot to do.

Michael Fowlks, Law Enforcement Chief presented Rule R657-60, Aquatic Invasive Species Interdiction, using a PowerPoint presentation. This rule is the next piece in the puzzle following the AIS management plan. We realized we had an issue with being able to interdict and enforce with regard to *Driessena* mussels, because most of their life stage they are not visible. We needed to have some legislation, which enhanced our ability to interdict when we could not see when these invasive mussels were being carried. Senator Greiner carried Bill 238, which passed in the last session and is currently in effect as of May 5, 2008. Mr. Fowlks went over items specified by code to be included in the rule, definitions, and infested waters. (See Powerpoint Presentation for details) Possession of *Dreissena* mussels is prohibited and written approval from the Utah Division of Wildlife Resources' Director is required to import or possess these mussels. If someone discovers or has reason to believe mussels are present, they must report it at Utah Division of Wildlife Resources' offices, through the website or through the UTIP hotline. He went over the details for transportation of conveyances, certification that is required to launch in a water body, and water body closure upon confirmation of microscopic or visible forms by the Utah Division of Wildlife Resources. Notifications will be given as updates on the status of the closure by the controlling entity. Control plans will be required once a closure is ordered, but may be prepared in advance to prevent closure. Relative to Ports of Entry, the Utah Division of Wildlife Resources will negotiate a Memorandum of Understanding with the Utah Department of Transportation for the use of Ports of Entries. This concluded the presentation. He asked if there were any questions.

Mr. Perkins [board member] said we have a designation of the Board of infested waters, what does that do when the Board makes that designation?

Mr. Fowlks said in order to stop someone and compel them to decontaminate, we have to have a list of infested waters. This provides us with an opportunity, if they are transporting from infested waters, we can stop them, ask some questions and have them decontaminate.

Mr. Brady [board member] said on the Utah Department of Transportation port of entry near Kanab on the way to Wahweap, are you required to stop there every time?

Mr. Fowlks said the Memorandum of Understanding will cover when and where we will do those checks and signage will be required. The bigger boats that are transported by major carriers are required to stop already.

Regional Advisory Council (RAC) Recommendations to the Wildlife Board Regarding R657-60

Southern – Mr. Albrecht [RAC Chair] said there were a lot of the comments that were received at their RAC that have come up today. We had a lot of discussion and a lot of questions answered. We passed it unanimously.

Southeastern - Mr. Sanslow [RAC Chair] said some of their questions were answered at their meeting and it was voted unanimously to accept as presented. His RAC understands what a serious problem this is and they want to commend the Utah Division of Wildlife Resources for their actions.

Central – Mr. Kent [RAC Chair] said their questions were answered at their meeting. There was very little discussion and it was passed unanimously.

Northeastern – Ms. Amy Torres [RAC Chair] said there was interest from the public and the RAC in setting up commercial decontamination stations and evidently there is no rule for these as of yet. They are being developed. They passed the proposal unanimously.

Northern – Mr. Slater [RAC Chair] said they had similar questions and had good interaction. They passed the proposal unanimously. The Regional Supervisor took a quick poll of the public in the audience of the education that was going on. It was interesting to see that a good majority has heard, seen or talked with someone about this problem. The public education process is occurring.

Wildlife Board Chairman Niemeyer asked if there was any public comment and there was none.

The following motion was made by Rick Woodard, seconded by Keele Johnson and passed unanimously.

MOTION: I move that we approve Rule R657-60 Aquatic Invasive Species Interdiction as presented by the Division.

August 7, 2008 Salt Lake City, UT: Chair Paul Niemeyer called the meeting to order; there were 5 interested parties in attendance in addition to the Utah Wildlife Board members, RAC Chairs or their designees, and Utah Division of Wildlife Resources employees. The Utah Aquatic Invasive Species Management Plan was not an agenda item of this meeting, but an amendment to Rule R657-60, Aquatic Invasive Species Interdiction was an agenda item. Implementation of the rule has direct bearing on the Utah Aquatic Invasive Species Management. Board minutes are as follows:

Larry Dalton, Utah Division of Wildlife Resources' AIS Coordinator presented this amendment. "They have found quagga mussels in Lake Granby in Colorado. This lake is at the headwaters of the Colorado River." When Colorado announced that finding, Mr. Dalton was in a meeting with experts on the quagga mussels. One of the experts [Bob McMahon] was convinced that these mussels will make the trip down the river to Lake Powell. There were people from the mid west and east at this meeting who were faced with this 20 years ago and they told him not to panic. You will get them and this is your first time at bat.

The Division is asking that Rule R657-60, Aquatic Invasive Species Interdiction, add Lake Granby Colorado to the list of infested waters in R657-60-2(2)(g). We are probably going to see more listings in the future.

A question that the Board might have, is how good is this finding. Colorado uses an approach almost identical to the system Utah is using to identify these mussels. (See Attachment #2 for details) [A positive find via microscopy of a plankton sample occurred, which was followed by PCR on that sample by two independent labs.]

Mr. Hatch [board member] asked if it would make sense to add this water and any other waters that are identified.

Mr. Dalton said he discussed this with Mr. Bushman [assistant Utah Attorney General assigned to Utah Division of Wildlife Resources] and he advises against this.

Mr. Hatch said we could add any waters that are tested by methods approved by the state of Utah.

Mr. Bushman said when this bill was written he argued for that broader authority [with Utah Legislative legal counsel], but in statute it requires the Board action to add these waters. The language they wanted was "an infested water is defined as any water or geographic area that the Wildlife Board designates in rule as being infested." We are not ready to list the entire Colorado River drainage as infested waters. The statute is what ties our hands. These infested waters are the catalyst by which you could be held

criminally liable if a boat has been in the waters and it spreads the mussels, because it was not disinfected.

We have drafted a rule that the Board will see sometime in August. This will allow the Board to meet telephonically. We will need to give 24 hours notice and will have a site set up at the Division where anyone can come sit and listen. The rest of the Board can participate from home, work or wherever. We can amend this rule in 3-4 days once we are made aware of an infested water. If we see a chain reaction down the Colorado, we might have to go to designating areas.

Mr. Perkins [board member] said if we have mussels in Lake Granby, why wouldn't we designate the waters immediately downstream from there?

Mr. Bushman said we would have to designate the entire Colorado River in Utah as well, down to Lake Powell. We are not to a point where we have to do that, since we have not actually found it.

Director Karpowitz [Utah Division of Wildlife Resources and Executive Board Secretary] said everybody going in or out of Lake Granby will have to decontaminate. It is a total lock down. That is another safeguard we have. We will also step up our monitoring of Lake Powell on the upper end. We have been testing it every two weeks. Lake Granby flows into the Colorado and the North Platt, both ways across the Continental Divide.

Mr. Woodard [board member] asked if Director Karpowitz sees us as going into a complete lock down.

Director Karpowitz said our plan says that if it shows up in Lake Powell we will go into containment mode, which means that any boat that comes off Lake Powell will have to be decontaminated. When anyone tries to launch into another water, if they have been in Lake Powell, they will have to produce a certificate of decontamination.

Mr. Dalton said Utah is being seen as a leader in this situation. We talk with someone from the surrounding states every other day. We are in constant communication.

Mr. Perkins asked if we have talked to the river rafting businesses in Utah.

Mr. Dalton said as this find happened, we asked our Northeast and Southeast regions to get in touch with the river guys and start saying they need to beef up the information they share with customers and employees. One of the Division employees went into the BLM office in Monticello to talk to them. They issue most of the permits on the Colorado River system.

The following motion was made by Rick Woodard; seconded by Ernie Perkins and passed unanimously.

MOTION: I move that we add Lake Granby Colorado to the list of infested water in the Aquatic Invasive Species Interdiction Rule R657-60.

August 28, 2008 Salt Lake City, UT: Chairman Niemeyer welcomed the audience and introduced the Wildlife Board members and RAC Chairs. Five members of the public were present.

AIS Management Plan **(Action)**
Larry Dalton, Wildlife Program Coordinator presented this agenda item. Since the May/June RACs the draft plan has been available for public review. It has been on the DWR website for review. He is here today to achieve Board action to approve the plan. He then gave a quick summation of the plan as follows:

We have a number of aquatic invasive species that threaten the state of Utah. We were fortunate to capture the legislature's attention in the last session and we spent 1.1 million dollars in the last budget in the attack on these species, mostly focusing on the dreissena mussels, which are the quagga and zebra mussels. The legislature saw the merit of this program continuing and appropriated 1.4 million dollars of ongoing general funds. We have been working on the plan with a large team, state, federal and private interests, and it is ready for Board approval.

Steps that will happen in the future are RDCC will look at this plan next month and comment on it. In early November we will take this to the Aquatic Nuisance Species Task Force in Washington D.C. This is the first step in getting this plan ultimately approved. The plan targets dreissena with most effort to keep quagga & zebra out. Much effort on New Zealand mud snail management, limited effort on Eurasian Watermilfoil management and less effort on other AIS management outlines the efforts being made. The plan with appendices is several hundred pages long and has been provided to the Board.

RAC Recommendations
After a report of some discussion and questions in the various RACs, all the RACs passed the proposal unanimously

The following motion was made by Rick Woodard, seconded by Ernie Perkins and passed by the Utah Wildlife Board unanimously.
MOTION: I move that we accept the AIS Management Plan as presented by the Division.

Appendix H
UDWR's Aquatic Invasive Species Team

STOP AQUATIC HITCHHIKERS!™
Prevent the transport of nuisance species.
Clean all recreational equipment.
www.ProtectYourWaters.net

24/7 Request Decontamination or Report Violations
1(800) 662-DEER (1-800-662-3337)

SOUTHERN REGION

- AIS BIOLOGIST: CRYSTAL STOCK (decontamination & questions)
  - Cell (435) 691-2427
  - Office (435) 865-6100
- LAW ENFORCEMENT: Lt. SCOTT DALEBOUT (violations)
  - Cell (435) 691-3588

SOUTHEASTERN REGION

- AIS BIOLOGIST: DAN KELLER (decontamination & questions)
  - Cell (435) 630-3132
  - Office (435) 613-3720
- LAW ENFORCEMENT: Lt. CARL GRAMALICH (violations)
  - Cell (435)-820-6011

CENTRAL REGION

- AIS BIOLOGIST: EVAN FREEMAN (decontamination & questions)
  - Cell (435) 503-4066
  - Office (801)-491-5678
- LAW ENFORCEMENT: Lt. Scott White (violations)
  - Cell (801) 243 3061

NORTHERN REGION

- AIS BIOLOGIST: CANDACE HUTCHINSON (decontamination & questions)
  - Cell (801) 648-6315
  - Office (801) 476-2740
- LAW ENFORCEMENT: Lt. Scott Davis (violations)
  - Cell 801 725-8988

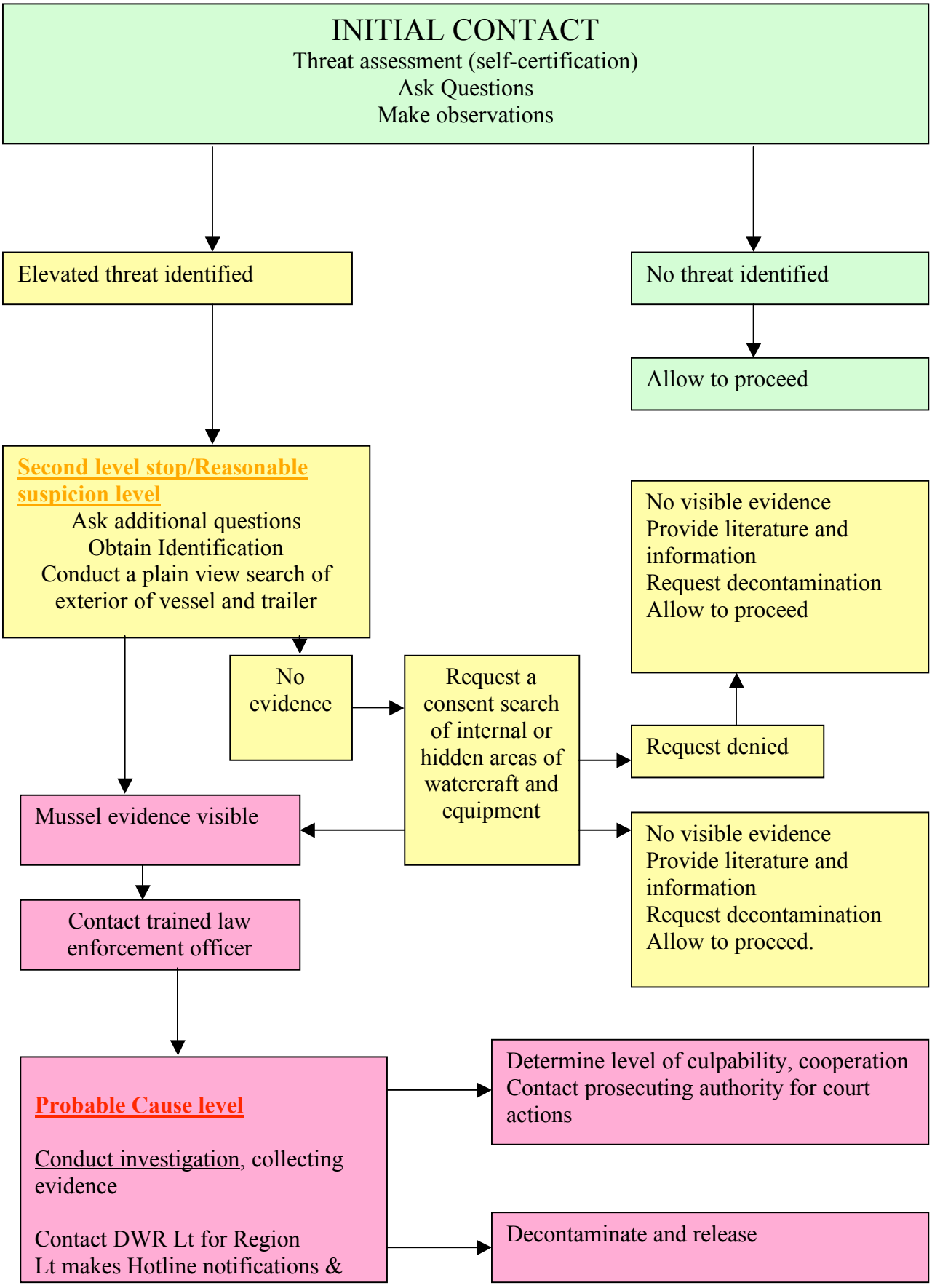
NORTHEASTERN REGION

- AIS BIOLOGIST: NATALIE MUTH (decontamination & questions)
  - Cell (435) 790-8938
  - Office (435) 781-9453
- LAW ENFORCEMENT: Lt. TORRY CHRISTOPHERSON (violations)
  - Cell (435) 790-2291

NOTE: If any lieutenant is unavailable, contact Captain John Pratt 801 450-3311

General Questions about UDWR's AIS program
Larry Dalton, AIS Coordinator, Salt Lake City, UT
801 652-2465

Appendix I *Dreissena* Interdiction Protocol



APPENDIX J

GLOSSARY OF TERMS

Aquatic: Relating to water, including wetlands.

Aquatic Invasive Species (AIS): AIS are defined as water-associated non-native plant and animal species that threaten the diversity or abundance of native species due to their uncontrollable population growth, causing ecological instability of infested waters, or economic damage to commercial, agricultural, aquacultural, or recreational activities dependent on such waters. The term AIS in many documents and laws is referenced as Aquatic Nuisance Species; for purposes of this plan both aquatic invasive species and aquatic nuisance species mean the same thing.

AIS Infested Waters: Waters with an established population of AIS (i.e., having the ability to reproduce). In the instance of *Dreissenid* mussels, infested waters must be declared through Utah Wildlife Board action resulting from a scientific protocol that includes visual observation of the animal, which may include microscopic observation, followed by a positive finding from two independent deoxyribonucleic acid (DNA) polymerase chain reaction (PCR) tests of tissue.

Biocontrol: The use of living or dead organisms, such as predators, parasites, bacteria and other pathogens (disease causing microbes or organisms) to control AIS.

Control: Any efforts by man to eradicate (eliminate), suppress or reduce populations or otherwise manage AIS.

Fouling: Clogging, entanglement or obstruction by AIS of the hulls on watercraft or their operational equipment; and clogging, entanglement or obstruction by AIS of water intake structures, pipes or other water transportation facilities.

Media: Multiple mediums of communication including, but not limited to signs, billboards, brochures, newspapers and other publications, internet, and radio or television broadcasts.

Native Species: Biota (plant or animal species) occurring naturally in a specified geographic area comprising its ecological range.

Non-native Species: Biota (plant or animal species) not natural to a specified geographic area, having been introduced either purposely or unintentionally. Only a select group of non-native species are recognized as AIS, since many others create a quality of life desired by man.

Appendix K

Implementation Table for the Utah Aquatic Invasive Species Management Plan

(NOTE: Plan implementation is entirely dependant upon sufficient budget being available.)

Purpose: Develop and document a program and associated protocols to be implemented for AIS management within Utah.

Goal: Improve the ability of natural resource management entities within Utah to prevent invasion of AIS into the state, and to contain AIS through accepted management practices to areas that are either already infested or become infested.

Outreach Objective: The Utah AIS Management Plan will establish and increase outreach efforts directed at public education. The intent is so Utah's public, particularly the media, governmental agencies, outdoor-associated recreational organizations, boaters, and anglers will realize the threats and impacts from AIS, and become partners in AIS education, interdiction and decontamination, as well as management.

Media Strategy: Coordinate Utah's media (national, regional, statewide and local newspapers, magazines, radio stations and television stations, including targeted programming ("Utah at Your Leisure" and "Roughin It Outdoors") to repeatedly tell the AIS story, by identifying opportunity for the media to market their publications and broadcasts, promoting the "Stop Aquatic Hitchhikers" slogan in combination with Utah's decontamination protocols.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Media 1	Promote proactive AIS stories to the media--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Media 2	Promote reactive AIS stories to the media--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Public Education Strategy: Educate the public, particularly Utah boaters, at a variety of venues (e.g. organized angler and boater meetings, International Sportsman Expo, Greenspan Boat Show, Garden Show, state and county fairs, launch sites and Utah's Ports of Entry) about AIS. The process will be to explain the AIS issue, and encourage the public to spread the "word," creating peer pressure for decontamination compliance. This strategy also includes presentations to natural resource management agencies within Utah and across the west about the AIS issue.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Public Education 1	Present and explain the AIS story statewide to tribal, federal, state & local governments, and sportsman groups--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Public Education 2	Present and explain the AIS story statewide at expos, shows & fairs--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Public Education 3	Present and explain the AIS story statewide at boat launch ramps--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Public Education 4	Present and explain Utah's AIS program worldwide to other natural resource management entities--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Public Education Strategy (continued): Pursue cooperative opportunities to expand the education strategy to venues like the Living Aquarium and their educational van (they visit schools in the Wasatch Front area of Utah), Hogle Zoo and their docent education program (they visit schools statewide), and the Utah Natural History Museum, all located in Salt Lake City, UT.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Public Education 5	Explore cooperative opportunity at other educational venues statewide to present and explain the AIS story--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Public Education Strategy (continued): Display AIS outreach product produced by Utah Division of Wildlife Resource statewide (e.g. highway billboards, tailgate wraps on UDWR trucks, boat launch ramps, water-based recreation areas, boat dealers and marine repair shops, restaurants, local dive shops, and sporting good stores).
Note: Cabela's and Sportsman Warehouse outlets are each willing and have facilities that can be used for public AIS presentations.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Public Education 6	Develop & display outreach product statewide at every conceiveable location in order to stimulate public recognition & reaction to the AIS problem--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Public Education Strategy (continued): Pursue opportunity to make AIS presentations at venues where water user groups gather (e.g. Utah Water Users Conference, river basin meetings, water rights managers meeting, etc.).

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Public Education 7	Develop presentations & displays about AIS, presenting them statewide at gatherings of water users or natural resource manages who regulate water users--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Next Generation Education Strategy: Coordinate with Utah's educators in concurrence with the state science coordinator to educate the next generation of boaters by developing formalized in-class-room tutorials for secondary level school teachers to present to their students. The educational content must correlate to Utah's core curriculum and be done in cooperation with Project WILD.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Next Generation Education 1	Consistent with the Utah Board of Education's core curriculum and in cooperation with Project WILD, develop presentations & educational product about AIS for use statewide by secondary school teachers--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Next Generation Education Strategy (continued): This strategy also includes web site development for AIS message delivery, and the sharing of educational material amongst educators, the Utah AIS Task Force and other states.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Next Generation Education 2	Coordinate with UDWR's web master for appropriate web site development to present the AIS story and make available associated educational material to Utah's public--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Next Generation Education Strategy (continued): Coordinate with appropriate local university and college personnel to make AIS presentations to their students, either in classroom settings or as a visiting lecturer at organized symposiums.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Next Generation Education 3	Develop presentations & educational product about AIS for use statewide by university educators or by professional ecologists as visiting lecturers--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Interdiction and Decontamination Objective: The Utah AIS Management Plan will facilitate increased interdictions of boats and equipment contaminated with AIS, requiring decontamination under authority of the Utah Aquatic Invasive Species Interdiction Act and Rule R657-60 Aquatic Invasive Species Interdiction in order to control the spread of AIS.

Interdiction Strategy: Utah Division of Wildlife Resources' staff, including authorized volunteers, Utah Peace Officers, which includes Conservation Officers and state Park Rangers, and Utah Department of Transportation Port of Entry Agents, under authority of the Utah Aquatic Invasive Species Interdiction Act and Rule R657-60 Aquatic Invasive Species Interdiction, and other properly trained natural resource management personnel, will interdict boats at launch ramps, administrative check sites, and Utah's Ports of Entry to detect boats and equipment contaminated with AIS.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Interdiction 1	Statewide, interdict boats and equipment potentially contaminated with AIS at launch ramps, administrative check sites, and Utah's Ports of Entry--yearlong	UDWR & Peace Officers & Port of Entry Agents	UDWR & Peace Officers & Port of Entry Agents	X	X	X	X	X

Decontamination Strategy: Boat owners and operators will be contacted in-the-field or at a variety of other venues, including through media publications or broadcasts, one-on-one education or at group presentations, in order to tutor them about AIS. The boaters will be provided guidance about how to decontaminate their watercraft and equipment as per established protocols.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Decontamination 1	Statewide, decontaminate boats and equipment contaminated with AIS at launch ramps, administrative check sites, and Utah's Ports of Entry, or other places of opportunity--yearlong	UDWR & Peace Officers & Port of Entry Agents	UDWR & Peace Officers & Port of Entry Agents	X	X	X	X	X
Decontamination 2	Statewide, educate boaters and others about how to decontaminate their potentially AIS infested equipment using an approved do-it-yourself method or an approved professional method--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Decontamination 3	Statewide, encourage boaters to routinely decontaminate their equipment after every boating trip--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Management Objective: The Utah AIS Management Plan will facilitate opportunity to apply contemporary natural resource management practices in order to regulate, control and eradicate AIS, allowing rehabilitation of infested areas followed by documented monitoring of success in all phases of management.

Plan Development Strategy: Utah Division of Wildlife Resources will prepare, implement and maintain a Utah Aquatic Invasive Species Management Plan, including periodic updates as scientific information evolves regarding AIS management, in concurrence with the Utah Aquatic Invasive Species Task Force and the U.S. Fish and Wildlife Service's national Aquatic Nuisance Species Task Force.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Plan Development 1	Develop, implement and maintain an approved AIS management plan for the state of Utah--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Public Review Strategy: Utah Division of Wildlife Resources subjected the draft Utah Aquatic Invasive Species Management Plan to a public review process that included Utah Division of Wildlife Resources' five Regional Advisory Councils located throughout Utah, approval by the Utah Wildlife Board (Appendix G). Once approved by the Utah Wildlife Board occurred, approval by the Utah Governor's Office was secured. Then, ultimate approval by the U.S. Fish and Wildlife Service's national Aquatic Nuisance Species Task Force ensued.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Public Review 1	Conduct a thorough, statewide public review of the Utah AIS Management Plan; after 5 years of implementation do it again (FY14), modifying the plan as needed	UDWR & AIS Task Force	UDWR & AIS Task Force	X				

Implementation Strategy: Utah Division of Wildlife Resources will work with Utah's Department of Natural Resources, Utah's Legislature, the Utah AIS Task Force and other natural resource management entities to secure adequate funding and cooperation for plan implementation and continuance.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Implementation 1	Yearlong, coordinate with decision makers across Utah and the Utah AIS Task Force in order to secure and maintain sufficient budget to conduct the Utah AIS Management Plan	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Implementation 2	Yearlong, monitor and manage the budgets associated with the Utah AIS Management Plan	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Implementation 3	Yearlong, coordinate statewide with the Utah AIS Task Force and partner agencies or groups in order to implement the Utah AIS Management Plan	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Implementation 4	Yearlong, coordinate within Utah Division of Wildlife Resources for development of annual performance management contracts for personnel assigned to the AIS effort	UDWR	UDWR	X	X	X	X	X

Research and Technology Strategy: Utah Division of Wildlife Resources has already contacted Utah State University's Fish and Wildlife Department to assess early detection methodologies, particularly biological arrays using protein markers for identification. Additionally multiple researchers at various labs have been quarried about the multiple, different deoxyribonucleic acid polymerase chain reaction tests (PCR) that are available. Further research may evolve based upon findings, need and available funds. It is intended that funds will be secured to maintain a long-term graduate research effort at Utah State University to be directed toward AIS issues.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Research & Technology 1	Yearlong, coordinate with Utah's research institutions, including the Fish Experiment Station in Logan, UT; working labs across the nation; and others to further early detection efforts and protective measures for AIS	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Research & Technology 2	Yearlong, perpetually puruse the scientific literature, sharing information to better the Utah AIS Task Force's understanding of AIS issues and management potentials for AIS	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Control and Restoration Strategy: The control of AIS is problematic to the extent that all the different species require varying approaches. For some species control or containment methods are poorly understood, although interest across the world is high, so research is ongoing. Findings from that research will be implemented as appropriate and practicable in Utah. The strongest control approach is to simply focus upon keeping AIS out of Utah or contained to areas already infested.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Control & Restoration 1	Yearlong, focus statewide upon approaches that will keep AIS from either arriving in Utah or for those that have already arrived, keep them contained to infested areas	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Control & Restoration 2	Compell boaters statewide to self-certify prior to launch that their watercraft have either not been used within the last 30 days on an AIS infested water or that their watercraft have been properly decontaminated--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Control & Restoration 3	In regards to *Dreissenid* mussels, coordinate statewide the development of rapid response plans for every boatable water prior to the mussells arrival or spread--yearlong	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Control & Restoration 4	Yearlong, coordinate statewide the development of rapid response plans to deal with newly arriving or spreading AIS	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Control & Restoration 5	Upon implementation of a rapid response, follow through to ensure that impacted biota are restored and that suitable mitigation ensues	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X

Monitoring and Evaluation Strategy: Monitoring for invasions of AIS or spread of existing AIS is a significant challenge as compared to monitoring and evaluation for control and restoration work. Utah AIS Task Force members and agencies will keep track of invasions of AIS or spread of existing AIS, documenting change in conditions annually.

Action/Task #	Description	Lead Agency	Funding Source	Occurrence for Planned Effort				
				FY09	FY10	FY11	FY12	FY13
Monitoring & Evaluation 1	Yearlong, monitor using appropriate methodology for arrival or spread of AIS statewide and document findings	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Monitoring & Evaluation 2	In regards to *Dreissenid* mussels, secure plankton samples from every boatable water when water temperatures are appropriate for reproduction and analyze as per UDWR protocol	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Monitoring & Evaluation 3	Yearlong, evaluate the effectiveness of the Utah AIS Management Plan, particularly the rapid response strategy and modify as needed	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X
Monitoring & Evaluation 4	During December of each year, prepare a summary report of outcome for conduct of the Utah AIS Management Plan and distribute/present as appropriate (e.g, Utah AIS Task Force, U.S. Fish and Wildlife Service Aquatic Nuisance Species Task Force, Western Association of Fish and Wildlife Agencies, Utah Legislature, etc.)	UDWR & AIS Task Force	UDWR & AIS Task Force	X	X	X	X	X